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MYELINOGENY AS APPLIED TO THE STUDY OF BEHAVIOR *

FREDERICK TILNEY, M.D.

AND

LOUIS CASAMAJOR, M.D.

NEW YORK

There is an increasing number of those who earnestly believe with Stewart Paton [17] that "the mists of superstition and ignorance are lifting and reveal to us the extent and importance of this new field of inquiry—the study of human behavior."

Although the general contents of this study may be easily perceived, it is perhaps advantageous to have some tentative definition of the field which it covers. Human behavior, according to a preeminent exponent of behaviorism, Professor J. B. Watson,[22] is the composite stream of reactions arising from the combination of vocal (laryngeal) organization, manual (somatic muscular) organization and visceral organization in man. Genetically, it comprises reactions of at least two varieties; unlearned reactions, more usually referred to as instinctive, and learned reactions conditioned by the individual's experience and development.

The attempt to investigate either of these two varieties of reaction in the adult is fraught with many difficulties. It could scarcely be otherwise, since adult behavior presents itself as a mass of intricate patterns derived from a veritable mosaic of diversified factors in human adjustment.

Much has already been gained by the study of behavior in its primitive expression as manifested by the infant. In infancy, the stream of reaction is nearest to its source and revealed in its simplest terms. From this starting point, accessions to it from the tributaries of growing experience may be recognized as they appear from time to time. Yet even this approach to the subject might, with great advantage, be prefaced by a better understanding of behavior in lower animals. For it cannot be denied that many human reactions indicate the influence of an indelible phylogenetic imprint. This is more especially true of the unlearned reactions; i. e., those performances which appear to be an expression of the individual's inherent endowment acquired as part of his heritage from a long evolutionary ancestry.

* Read at the Forty-Ninth Annual Meeting of the American Neurological Association, Boston, May 31 to June 2, 1923.

It has been assumed by many authorities that animal behavior may be explained as a series of reactions based on the conversion of adequate sensory stimuli into definite effector responses. This conception postulates a structural basis for behavior. It visualizes certain parts of the body designed to receive various stimuli and other parts to act as effectors. It also implies that somewhere in the organization there is a mechanism capable of managing the necessary conversion. This function of conversion is assigned to the many reflex arcs constituting the nervous system.

Our particular interest in the problem of behavior has taken form in the following question: What is the sequence in the development of reactions in the young growing animal, and may these several reactions be explained by specific reflex arcs?

A number of experimental methods may be employed in the attempt to answer this question, but we decided first to apply Flechsig's "law of myelinization" to determine whither that approach might lead us.

Paul Flechsig,[9] after a long series of researches, proposed certain laws concerning the developmental sequence of fibers in the nervous system. This sequence was based on the successive periods at which the different systems of fibers received their myelin sheaths, a process which Flechsig called *myelinogeny*. His fundamental myelinogenetic law states that *the myelinization of nerve fibers in the developing brain follows a definite chronologic sequence such that those fibers belonging to particular functional systems mature at the same time.* By the maturing of nerve fibers, Flechsig meant the assumption by them of their myelin sheaths. He was by no means the first to recognize the general nature of this phenomenon. Meckel,[13] as early as 1815, observed that the medullary substance of the central nervous system developed quite gradually and that different parts became myelinized at different times, especially in the cerebral hemispheres where the difference in time in some instances amounted to several months. Meynert [14] also recognized differences in the time of medullation affecting the cerebral peduncle, and Vulpius [21] noted a belated appearance of medullation in the frontal lobe as compared with the central convolutions.

Flechsig's myelinogenetic law has not, however, gone unassailed, and many authorities are still unwilling to accept it either because of cogent objections to it as a principle, or because it needs much further confirmation before it may be regarded as established. Von Monakow [15] believes that vascularization in the several areas of the brain plays a much more important rôle in the process of myelinization than does the establishment of function. C. and O. Vogt [20] are of the opinion that the caliber of the nerve fibers has much to do with the time of myelinization

as the areas whose axons have thick sheaths receive their myelin relatively late. Déjerine [6] was averse to accepting the law as it stands; while Broadmann [5] says that, all in all, myelinization is still an unsolved problem. Herrick,[10] however, believes that the criticisms may not be wholly justified, although it seems premature to attempt such detailed analysis, especially of the cortical mechanisms in a psychic process, as Flechsig has elaborated. He concludes that the factors determining the sequence of myelinization are exceedingly complex, and that it is impossible at present to formulate the law of the myelinogenetic development of the brain.

Concerning the chemical and physical properties of myelin itself which plays such an important rôle in the development of the nervous system, there is also much discussion. This substance was first recognized by Virchow [19] in 1854 as identical with or at least chemically allied to the medullary covering of nerves. It exhibits, according to Virchow, a characteristic morphology and develops processes of irregular form having a double contour. It is readily soluble in hot alcohol, but precipitates on cooling. When brought into contact with water it quickly swells. It is soluble in ether, chloroform and turpentine, and reacts slowly to weak acids and alkalis.

Myelin has been known for the past fifty years to have a wide distribution throughout the body, although it occurs in largest amount probably in the nervous system. It has been detected under normal conditions in the suprarenal cortex of man and several other vertebrates, in the granular cells of the corpora lutea, in the thymus gland, in the blood, spleen, mesenteric chyle, bile and thyroid gland. Pathologically it occurs in fatty and atheromatous degenerations of the aorta, heart, lungs and kidney, also in hard and soft cataracts of the crystalline lens as well as in sarcoma and carcinoma. The chemical nature of myelin appears to be extremely complex. Beneke,[4] in 1862, recognized *cholesterin* as its basic constituent, and concluded that animal and vegetable tissue which possessed no cholesterin produced no myelin. Liebreich,[11] in 1865, contradicted this idea, claiming that *protargon*, which he was first to isolate, was the essential element in myelin. But protargon has been shown to dissociate into lecithin and cholin or neurin oleate. Indeed, Adami and Aschoff [2] have favored the view that myelin globules are probably an oleic acid compound; that is, a soap of oleic acid of greater or less complicity. Adami, by means of the polarizing microscope, demonstrated the interesting fact that myelin globules may present a double refraction, and he concludes that under certain conditions Virchow's myelin may be shown to possess this characteristic reaction demonstrating its fatty nature. As such it belongs to that remarkable class of substances possessing an intermediate state of fluid or ductile crystals.

Investigating the chemical nature of myelin by means of different strains, Ellermann,[8] in 1903, found that the several agents were selective in their reactions. Thus he concluded that the substance which reacted to Weigert's stain, also to Heller's and Allerhand's safranin and methylene blue stain, is a derivative of protargon. Direct osmiumization is not due to a lecithin reaction, but rather to some substance split off from it.

The most careful and enlightening work concerning the nature and source of myelin is that of Wlassak,[23] in 1898, whose conclusions are of such importance as to merit a rather extensive summary here. According to Wlassak, the following constituents of the myelin group are demonstrable by modern methods: fat and lecithin by direct treatment with osmic acid; fat alone by the Marchi method; protargon by Weigert's hematoxylin stain. Myelin is first demonstrable in the embryonic central nervous system in the protoplasm of the spongioblasts. The sources of this first accumulation are the myelin masses found in the connective tissue cells of the pia. A remarkably abundant collection of myelin appears in the spongioblasts and ependymal cells. The source of these deposits is the blood vessels of the pia, which are practically ensheathed by myelin on the side directed toward the nervous system. In a manner similar to the spongioblasts and ependymal cells, the epithelial cells forming the roof plate of the third and fourth ventricles have the capacity of accumulating myelin. In the lower animals, this capacity is apparently preserved in postembryonic life.

During the earliest embryonic stages, lecithin and fat alone are demonstrable in the central nervous system; later, protargon makes its appearance. After the blood vessels have grown into the central nervous system, the accumulation of myelin by the ependymal cells subsides in most classes of animals. The myelin is now found principally around the blood vessels, the lecithin and fat close to the vascular walls and the protargon at a distance from them.

In the peripheral nerves, the myelin is first found in the connective tissue cells which encase the nerve fibers. Later, only the myelin droplets adjacent to the fibers remain visible, while there is no accumulation in the endoneural and perineural connective tissue.

From the foregoing facts, it follows that the myelin is carried to the nerve fibers from the outside and is therefore of exogenous origin. It does not necessarily follow that an extensive chemical change of the myelin occurs with the entrance of the myelin into the sheath of the nerve fiber. The early appearance of myelin, especially of lecithin and fat, in the central nervous system at a time when nothing is as yet to be seen of medullated fibers, renders it probable that the accumulation of these substances in the protoplasm of the spongioblasts is related to

the structure of other constituents besides the nerve fibers. The actual source of the myelin must be sought in the blood to whose constant constituents, lecithin and fat belong.

The nervous supporting tissue, at any rate in the embryonic organism, possesses not only a mechanical but also a chemical function—it is a transmission apparatus for definite substances which are derived from the blood and carried to the nerve fibers. The dependence of the myelin sheaths of the nerve fibers on their functional activity does not contradict the assumption of an exogenous origin of the myelin. It is not so much the supply of myelin to the nerve fiber as it is its uniform distribution which is caused by the chemical change imposed on the axis cylinder through its functional activity.

How the constituents of such a complex chemical substance as myelin may be conveyed to the nervous system from certain exogenous sources, and evidenly through the agency of the blood, is not difficult to conceive. According to Wlassak, these constituents at first are widely and rather irregularly scattered throughout the neuraxis. Yet from this diffuse distribution the ultimate deposition of myelin about the axis cylinders follows a remarkably selective program. Definite groups of fibers, such as the posterior longitudinal fasciculus, the predorsal fasciculus, the mesial and lateral fillets, the pyramidal tract, the cerebellar tracts and other similar systems of fibers take on their myelin sheaths according to a fixed chronologic schedule. This chronological schedule differs in different species, but in each species myelinization seems to be timed by an unvarying regularity. The fact that myelinization does affect such well recognized functional systems of fibers in accord with a definite chronologic sequence calls for more light on the presumable relation between this process and the maturing of function; that is, the establishment of impulse conduction.

Is it possible that the appearance of definite behavioral components in the growing animal coincides chronologically with the myelinization of definite fiber systems? Should such prove to be the case, would we not come measurably nearer to a formulation of the myelinogenetic law and would not a little advantage be gained from a method which might afford some structural basis for the further analysis and study of behavior?

The method employed in this study has had three aspects: First, the reactions of young animals were observed from the time of birth, day by day, to the maturity of adult life. During this observation the initial postnatal reactions were first noted, and subsequently each new reaction or group of reactions was recorded as it made its appearance. Each of these accessional reactions marked a critical stage in the development of behavior. The chronologic succession of these critical stages resulted in the final upbuilding of adult behavior. Second, the central

nervous system was removed from animals at the time of birth and at each critical stage thereafter. After removal the brain and spinal cord were prepared for the Pal-Weigert method, which gives the most reliable myelin stain, and cut in serial sections. The third aspect of the study was the attempt to correlate the functional reactions at birth and in each critical stage which followed, with the myelinized fiber systems making their appearance in the nervous system at these several periods of behavioral development.

The animals which were most intensively studied included many litters of kittens. In addition, however, considerable attention was devoted to the behavior of young rats, rabbits and guinea-pigs. Certain distinctive differences were noted in the chronologic sequence according to which these four species developed their fundamental behavioral components. These differences will undoubtedly prove of great importance in a subsequent investigation of comparative behavior and its significance. We would limit our present observations, however, to the behavioral development in the cat and particularly to the early somatic motor reactions.

In this attempted analysis of behavioral components in correlation with the myelinization of the nervous system, we fully appreciate how hazardous it would be to draw more than tentative conclusions for a long time yet to come. We present our observations merely as a preliminary report which may be of interest to other workers in this field, but would make it clear that our position in the matter is subject to such changes as we may from time to time be led to make in the course of this research. Mention has already been made of behavioral component, and it may be said that any attempt to define so mobile a combination of reactions would require more discussion than would seem warranted at present. We have confined our attention to the somatic behavioral components which for our own guidance in the matter we have considered as specific reactions effected by the skeletal muscles and serving a definite purpose in the life of the animal.

For a general correlation between these somatic behavioral components and the myelinogenesis in the brain, reference is made to Figure 1, which shows eight critical stages in the myelinogenetic process. From the behavioral standpoint, these stages correspond to the reactions of the first day of life when the kitten is able only to make its way to the mother and nurse. They carry it through the various periods when it acquires an effective locomotion, is able to walk, run and jump, develops its own offensive and defensive acts, learns to feed and hunt for itself, acquires a regulated control over its dejecta and enters on the sexual activities which eventuate in the initiation and ultimate achievement of reproduction.

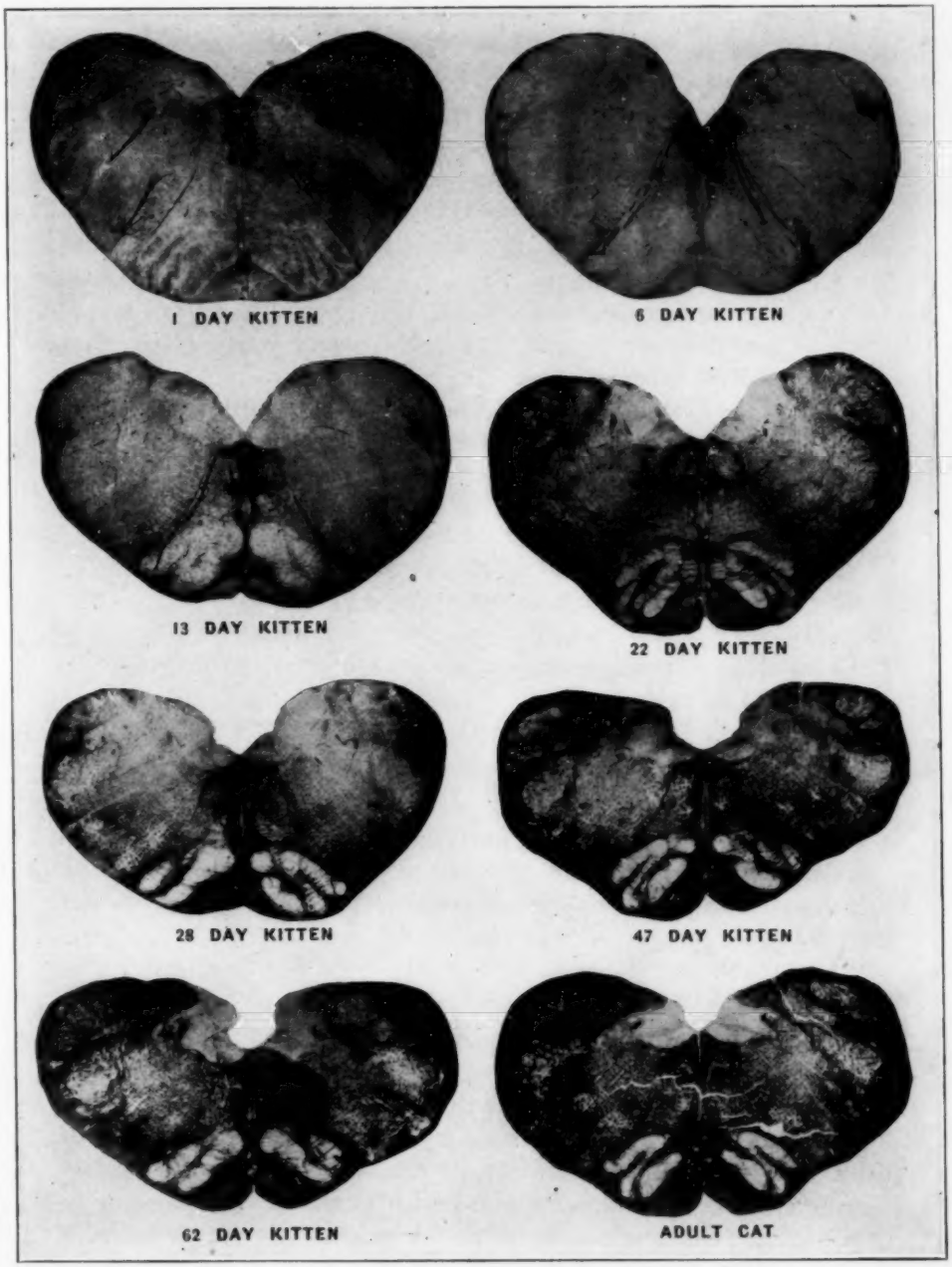

Fig. 1.—Cross sections of the cat's brain through the midolivary level of the medulla oblongata. This series illustrates the progressive myelinization at several critical stages of development. The widely separated localities of the earliest myelinization are clearly shown.

Although we have been able to distinguish a number of somatic behavioral components up to and including the ninetieth day, for reasons of limitation of space it was deemed wisest to restrict our presentation to the conditions of the first two weeks. The following tabulation, however, gives the chronologic sequence in the development of behavioral components in the reactions of the domestic cat from birth up to and including the thirty-first postnatal day.

1. Postural Reaction: Appears two minutes after birth.
2. Crawling-Approach Reaction: Appears eight minutes after birth, the swimming reaction appearing synchronously.
3. Sucking Reaction: Appears ten to twelve minutes after birth.
4. Synergizing Reaction: Appears on the seventh day.
5. Primitive Escape Reaction: Appears on the seventh day.
6. Eye-opening Reaction: Appears on the seventh day.
7. Eye and Head-turning Reaction: Appears on the fourteenth day (first appearance of visual pursuit).
8. Sitting Reaction: Appears on the twentieth day.
9. Walking Reaction: Appears on the twenty-second day.
10. Scratching Reaction: Appears on the twenty-third day.
11. Backing Away Avoiding Reaction: Appears on the twenty-fifth day.
12. Running Reaction (in pursuit or escape): Appears on the twenty-sixth day.
13. Pawing Reaction (with forepaws in play): Appears on the twenty-sixth day.
14. Washing Reaction (with forepaws to face): Appears on the twenty-sixth day.
15. Auditional Head and Ear Turning Reaction (in response to sounds): Appears on the twenty-sixth day.
16. Lapping Reaction (drinking milk from saucer): Appears on the twenty-ninth day.
17. Escape Defense Reaction: Appears on the twenty-ninth day.
18. Climbing Reaction: Appears on the thirty-first day.

Other reactions, such as burying defecta, pursuit and hunting, defense, attack and sexual activity, appear at later periods but with somewhat less chronologic uniformity.

Our present inquiry is especially concerned with the first seven of these behavioral components, which we consider distinctive and specific somatic reactions. We have endeavored to recognize for each one of these reactions a specific neural mechanism, and it seems probable that such a structural basis may be distinguished in the nervous system in consequence of fiber myelinization.

Although we would not take the position that the reflex arcs to which we have attributed the several components are indisputably the morphologic structures which control the reactions in question, we are

convinced that these reflex pathways may be put forward as offering reasonably satisfactory explanations for the behavioral components thus far identified. In order to maintain that these reflex arcs actually do control the reactions under consideration, there is need of much experimental investigation in advance of the field which we aim to cover at present.

Each behavioral component is determined by peripheral stimuli whose effective utilization requires the following physiologic and morphologic conditions:

1. Introduction by adequate sensory receptors.

2. Conduction by proper central pathways.

3. Conversion of the afferent stimuli into effector impulses in specialized centers of the neuraxis.

4. Transmission of such impulses by efferent systems.

5. Distribution of this energy to definite effector organs for the production of motor performances.

From this brief synopsis it will be observed that the essential elements of reflex arcs are here indicated. These arcs are usually complex in their organization. Afferent conduction alone may demand a combination of several tracts with incidental nuclear relays in their course. The conversion from sensory stimulus into motor impulse often calls into play the extensive activities of correlating areas, such as the cortex of the cerebellum or the tectal region of the mesencephalon.

ANALYSIS OF THE POSTURAL REACTION

Immediately after birth the young kitten usually lies on its side. In some instances it is partially supine. Two minutes after birth the animal begins to make the necessary movements to turn it from its side or back into a belly-down position. For obvious reasons this position of the body has been termed the *optimum physiologic posture*. It would be impossible for the animal to begin its efforts for existence in any other position. In turning from its back or side to gain this posture, the segments of the kitten's body follow a regular order of movement. The head is first rotated to the right or to the left by the neck muscles so that the ventral surface of the throat and chin come into contact with the surface of support. Next the shoulder girdle is rotated in the same direction as the head. Following this rotation the thoracico-abdominal structures are so turned that the ventral surface of the thorax and abdomen come to rest on the supporting surface; and finally, the pelvic girdle is rotated ventrad.

This act has the appearance of such a fundamental behavioral component that its neural mechanism seemed almost certain of discovery.

The central nervous system of the kitten immediately after birth, when investigated with reference to the tracts myelinized at this time, indicated that the animal must depend on some receptors other than those of the muscles, skin, bones or joints in order to bring about the postural reaction. Examination of the dorsal columns in the medulla oblongata, which contain the large afferent pathways from the somatic receptors, showed an almost complete absence of myelinization in these tracts, and for this reason it was argued that somatic stimuli probably do not play a part in the postural reaction.

The cerebellar connections are not established at this time, and no pathway from the cerebral hemispheres could be detected. On the other hand, a reflex mechanism which seemed capable of determining the postural reaction was already present and completely myelinized. This mechanism constitutes the *vestibulo-Deitero-spinal reflex arc*. The adequate sensory stimulus necessary to determine the optimum physiologic posture would in this light seem to arise in the internal ear, particularly in the semicircular canals, saccule and utricle, which structures are often referred to collectively as the *static labyrinth*.

It is probable that the great majority of vertebrates possess a definite gravitational pattern with reference to the posture of the head in relation to the structures in this labyrinth. The normal and inherent relation in most instances appears to require that the ventral surfaces of this structure shall be nearest to the surface of the earth. Any posture of the head which alters or modifies this relation, develops certain stimuli within the semicircular canals, saccule and utricle, thus causing the transmission of afferent impulses by way of the vestibular division of the eighth nerve. In the kitten at birth this vestibular pathway is open and ready to act, because the fibers in the vestibular division of the eighth nerve are already myelinized. These fibers may be traced to the lateral angle of the bulbopontile sulcus where they enter the brainstem. Their course as they traverse the tegmental portion of the bulb, passing dorsomesially, is shown at this stage in consequence of their complete myelinization. They may be followed dorsomesially until they come into relation with Deiters' nucleus. Here there are many large cells having the characteristics of motor elements. In this nucleus the sensory stimulus undergoes a conversion into an effector impulse. Starting from Deiters' nucleus, this impulse may make its way downward into the spinal cord along already myelinized fibers. Some of these fibers proceed from the nucleus toward the midline in a well-defined group situated in the dorsomesial part of the tegmentum, where after crossing, they immediately turn caudad, to pass through the medulla oblongata and into the spinal cord. Some of the myelinized fibers arising in Deiters' nucleus, however, do not cross the midline but

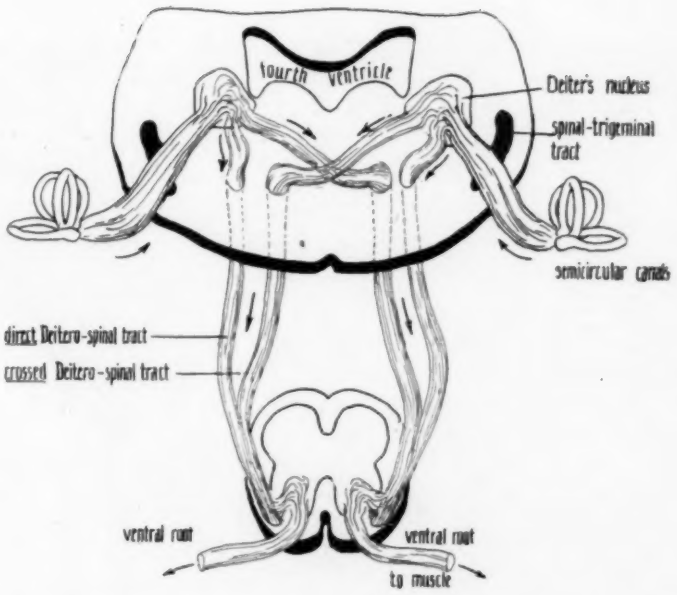

Fig. 2.—Diagram made from a graphic reconstruction of kitten's brain-stem at birth, showing the afferent and efferent arms of the reflex arc necessary to the postural reaction.

remain ipsilateral in their descent. These two Deitero-spinal tracts, one crossed and the other uncrossed, make their way to the various levels of the ventral gray columns of the cord through which, after appropriate synapses with the dendrites of the lower motor neurons, they transmit the effector impulses to the muscle of the neck, shoulder girdle, trunk and pelvic girdle. The diagram in Figure 2 shows the course of these tracts, and their relations in cross section are indicated in Figures 3, 4 and 5.

This fundamental reflex mechanism established in the early moments of life, continues to act in the interests of one of the chief behavioral

Fig. 3.—Section through the oblongata in the one-day kitten, showing relation of the Deitero-spinal fibers which occupy a position lateral to the heavily myelinized emergent fibers of the hypoglossal nerve.

assets for the further growth of the animal. Without such a mechanism, the kitten would be unable to maintain the most advantageous physiologic posture on which all its subsequent range of motor activities is based. There is not always a similar persistence of the other behavioral components which make their appearance at different chronologic periods. In many instances a component will appear in response to the requirements of a certain phase of development only to be replaced when those requirements no longer exist or others have supplanted them.

The manner in which the myelinized fibers of the crossed and uncrossed Deitero-spinal tracts leave Deiters' nucleus is shown in Figures 6, 7, 8, 9 and 10.

ANALYSIS OF THE CRAWLING APPROACH REACTION

Having attained the optimum physiologic posture, the next requisite in the life of the kitten is to establish contact with the mother's body as a source of food supply and body heat. The importance of such a reaction is demonstrated by the fact that in about eight minutes after birth, the kitten reaches the mother's body and shortly thereafter secures one of the nipples. The progress of events in this reaction are of much interest. Three or four minutes after birth the young animal, while lying in the belly-down position, begins to move its head from side to side. A moment later the legs also begin to move backward and forward in such a fashion as to advance the body toward the mother in the head-first direction. During this procedure the legs are used in a characteristic manner; the forelegs move alternately and the two hind legs more or less synchronously, while all four extremities act more as paddles than as supporting structures. The paw on the right side is moved forward and the claws extended so that some grasp on the supporting surface is obtained. Then the leg is moved slowly backward in such manner that the body is made to advance slightly. After the right leg has described its complete arc of motion, the left leg passes through similar stages, moving the body back toward the right and compensating for the slight deflection in direction which the movement of the right leg has produced toward the left. Meanwhile, and synchronous with the right and left phases of the fore limbs, the two hind legs are advanced to the sides of the body and then extended backward in order to give a propelling force to the hind quarters. The distance which the kitten traverses in passing from its position after birth to the mother's body is relatively short, and the time consumed in making this journey is about two or three minutes. All of this time the head continues to move from side to side, and the whole action of the animal seems to be expressive of a groping effort. Shortly before it reaches the mother, the animal voids a small amount of meconium which would seem to indicate a fairly active state of peristalsis already present in the intestinal canal. When the kitten reaches the mother's body it comes in contact with the abdominal wall and for some considerable time thereafter the side to side movements of the head continue, rubbing the nose and lips along the ventral surface of the mother. These movements of the head continue, making, however, shorter and shorter oscillations, and finally terminating when the mouth comes in contact with the nipple and the suctorial act begins. The average length of time consumed in this process is from eight to twelve minutes.

In the analysis of the crawling-approach reaction there is room for considerable speculation with reference to the source of the adequate stimuli which activate the movements. In the first place, it seems improbable that such stimuli arise in any of the somatic receptors. The tracts which ascend toward the brain bearing impulses from the skin, from the muscles and joints, the periosteum and the fascial planes of the body, have not at this time become myelinized, and for this reason

Fig. 4.—Section through the oblongata of the six-day kitten, showing relation of the Deitero-spinal fibers which occupy a position lateral to the heavily myelinized emergent fibers of the hypoglossal nerve.

it may be presumed that they are not functionally active. It also seems unlikely that any of the receptors of the special senses could be operative in these approaching movements. Vision certainly could play no part since the eyelids are not yet open; nor could the sense of taste or smell be called on in this connection, because there is as yet no myelinization in these fiber systems. The sense of hearing, however, does offer the possibility for a special sense to contribute toward the activation of

the crawling-approach movements, because its fiber systems are well myelinized. The availability of this sense to act in such capacity may, however, be questioned in consequence of the seeming inadequacy of auditory stimuli arising from the kitten's environment immediately after birth.

Certain sources of auditory stimuli must not, however, be overlooked in this connection. Throughout the process of delivery the mother continues to make the characteristic feline purring sound. To the observer this is quite audible. In addition to this purring, the mother also makes other sounds due to moving or stretching the body. Nothing in the nature of a cry or call has been heard during delivery so far as our experience goes. The sounds mentioned above might be adequate to produce auditory stimuli in the kitten which would contribute toward the initiation of the crawling-approach. We are of the opinion, however, that such auditory stimuli as do arise play another rôle, the nature of which will be discussed subsequently.

It would seem probable, therefore, that stimuli adequate to initiate the crawling movements of approach do not take origin in any of the distance receptors of the special senses nor in the extensive receptive organization of body sensibility. It thus became necessary to seek some other source for such stimuli.

In the changed conditions of the animal's existence immediately after birth, certain new factors make their first appearance. Thus, with the establishment of pulmonary respiration, the first inrush of air through the mouth and nasal cavity into the fauces, down the pharynx and eventually through the bronchial tree to the lungs, introduces an entirely new series of determinative stimuli. The reflected influence of these stimuli must have a pronounced and widespread effect on the centers in the neuraxis particularly concerned with the respiratory mechanism. The sudden entrance of air on the first respiratory activities, coming as it does, in the nature of a wholly new factor in the animal's life, floods the air passages with many stimuli heretofore unexperienced. The abruptness of this stimulus might be expected to cause excessive vagal excitation which would quite transcend the limits of normal respiratory requirement. Indeed, these stimuli might readily be conceived to cause an overflow beyond the respiratory boundaries on reaching the medulla oblongata, and thus stimulate some other related vagal elements as, for example, those supplying the gastro-intestinal tract. In any event, almost coincident with the establishment of the first respiratory activity, the stomach and intestines manifest an extreme degree of peristaltic movement. They also show a tendency for the coats of circular and longitudinal muscles to undergo a marked increase in tone, thus producing an extreme degree of contraction in the stomach

and in the duodenum. All of these facts, which may be observed in the kitten immediately after birth, stand in marked contrast to the slight degree of peristaltic motion in the gastro-intestinal tract prior to birth.

In view of these facts it seems fair to presume that after birth some new stimulus having access to the vagal territory so profoundly influences the pneumogastric innervation as to produce an increase of muscle tonus in the stomach and intestines, at the same time accelerating the peristaltic movement in the muscular walls of these structures. The

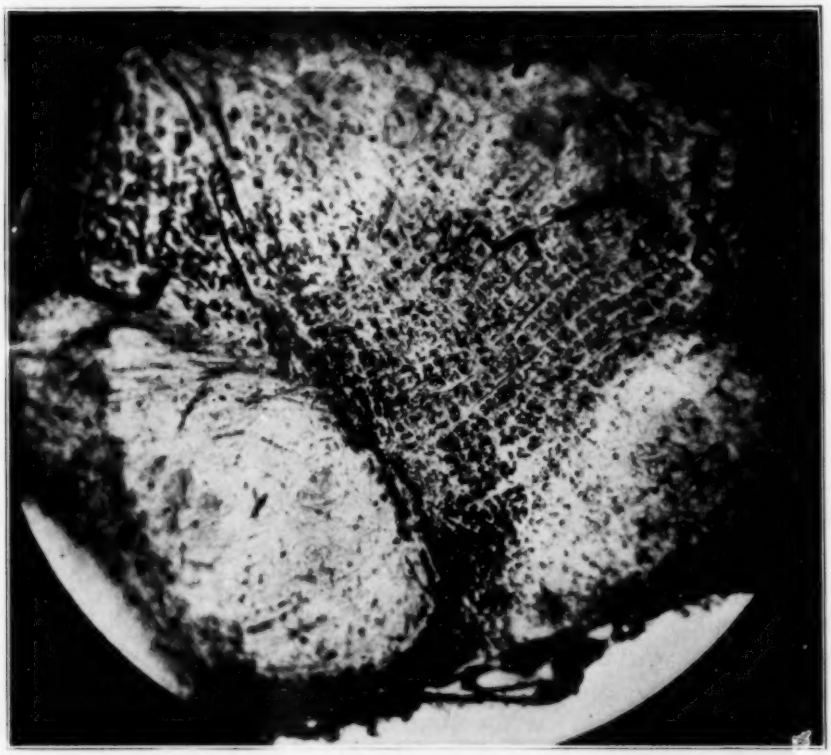

Fig. 5.—Section through the oblongata of the thirteen-day kitten, showing relation of the Deitero-spinal fibers which occupy a position lateral to the heavily myelinized emergent fibers of the hypoglossal nerve.

contracted condition of the stomach and intestines cannot be without its direct effect in producing afferent stimuli which make their way into the central nervous system. That these stimuli are closely allied with those habitually associated with the feeling of hunger, is probably true. For the state of hunger must fundamentally be dependent on a relatively empty condition of the stomach. The persistent contraction of the walls of the stomach, reducing the gastric cavity, together with the rhythmical peristaltic waves passing through its contracted musculature, may be

regarded as sufficient to give rise to a series of impulses passing to the medulla oblongata by way of the afferent vagal fibers. These fibers convey impulses to the dorsal vagal nucleus, which fibers being myelinized at birth are ready for such conduction.

From the dorsal vagal nucleus, myelinized fibers seen on the first day of life convey the impulses to higher centers in the neuraxis. Such a myelinized conduction system appears to be present at this time. By means of it impulses received from the stomach and intestines may ascend to levels in the midbrain, there to activate the complicated performances necessary to bring about the crawling movements of approach. This myelinized system is both ipsilateral and contralateral. Myelinized axons pass from the vagal nucleus mesially toward the raphé, where many of them cross in the dorsal medullary commissure to reach the dorsolateral portion of the opposite posterior longitudinal fasciculus. This bundle, which we designate as the posterior longitudinal fasciculus. or juxtaraphéal fasciculus, is in reality a complex group of fibers which occupies a juxtaraphéal position and at this time appears to consist of several distinct divisions. In the midolivary levels of the medulla oblongata, these divisions are four in number: (1) dorsomesial division, (2) ventromesial division, (3) dorsolateral division, and (4) ventrolateral division. The two mesial divisions are dense, compact fasciculi of fibers, while the fibers in the two lateral divisions are more scattered and less deeply stained. This arrangement of the myelinized fibers may be seen in sections of the medulla oblongata in the one-day kitten, and show to even better effect in the six-day and thirteen-day kitten (Figs. 11, 12 and 13). The fibers from the dorsal vagus nucleus, which cross in the dorsal myelinocephalic commissure, appear to enter the dorsolateral division of the juxtaraphéal fiber system. Fibers from several other sources also enter this division; namely, some myelinized fibers from the formatio reticularis lateralis and some directly from the vagus nerve. These fibers are shown in Figures 14, 15, 16 and 17.

It is not difficult to trace the axons arising in the vagus nucleus and making the connection above mentioned, because of the obliquity of the course of the fibers. They appear to be ascending elements which may be traced to the reticular formation in the tegmentum mesencephali. Such a pathway has already been predicated, although it will require careful degeneration experiments to decide ultimately the question of its actual existence. In all probability, such experimental evidence as this is unobtainable because of the great difficulty in severing the fibers of the medulla oblongata in the kitten on the first day of life without serious risk of immediate exitus. This would so impair the young animal's scanty neural mechanism as to make it incapable of producing the few simple adjustments necessary to the early moments of its extra-

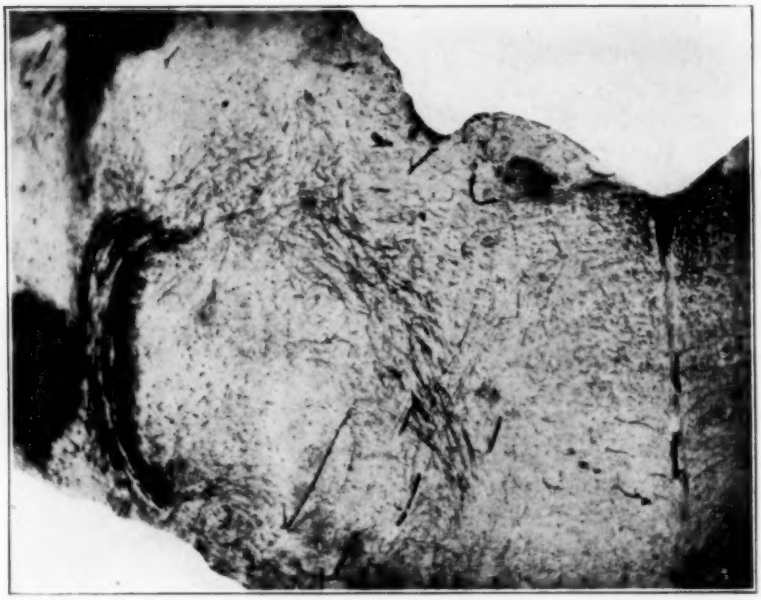

Fig. 6.—Section through Deiters' nucleus in the kitten at birth, showing the vestibular fibers entering the nucleus while the Deitero-spinal and a few Deitero-mesencephalic fibers are shown leaving it.

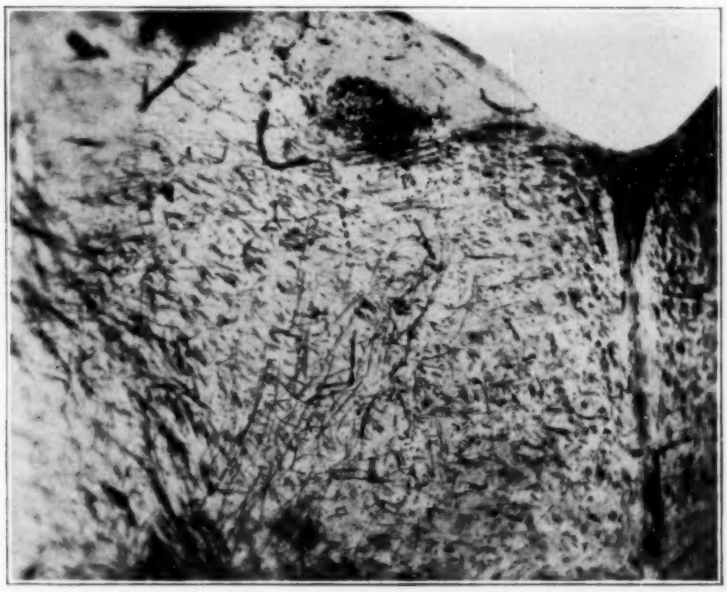

Fig. 7.—Section through Deiters' nucleus in the kitten at birth, showing the Deitero-spinal tracts passing ventromesially from the nucleus. The Deitero-mesencephalic fibers pass beneath the genu of the seventh nerve to enter the posterior longitudinal fasciculus. The Deitero-spinal fibers occupy an extreme lateral position in the section.

uterine life. We however, feel fairly confident in advancing the probability of this vagomesencephalic fiber system which, rising in the dorsal vagal nucleus and in the lateral portion of the reticular formation, makes its way by the juxtaraphéal fasciculi to the reticular formation in the midbrain. The stations in which these ascending fibers terminate are diffuse and irregular masses in the formatio reticularis of the mesencephalon. Many of the individual myelinzed axons may be seen as they approach their termination in this area of the brain.

It has been presumed that the reticular formation of the midbrain, and particularly that part of this formation which extends beneath the inferior colliculus to the intercollicular sulcus and forward to the caudal extremity of the superior colliculus, is responsible for the control of certain more or less complex motor performances. There is considerable evidence to show that stimulation of this part of the animal, both before and after decerebration, by means of the electrical current, will produce in the adult cat certain alternate paddle-like movements of all four extremities resembling in many ways the paddling movements seen in the young kitten during the crawling-approach reaction. These movements are both bilateral and rhythmically timed so that the two limbs alternate in their extension and the hind legs act more synchronously. At the same time that these movements of the fore limbs appear, there are also some side to side movements in the head, not unlike those already described in the early motor performances of the approach reaction.

Having reached this higher level in the midbrain, which is regarded by nearly all authorities as being possessed of certain correlating functions, it would seem likely that the impulses ascending from the vagal regions in response to the contractions in the stomach and intestines, would set in action certain groups of cells whose correlated activity is capable of determining a definite series of automatic associated movements. These movements might be called associated, because they involve the coincident cooperation of muscles which set in motion several different parts of the body, these parts so operating as to produce a performance which has a recognizable and specific purpose.

Admitting for the moment the possibility of determining in the reticular formation of the midbrain the pattern for such associated movements as would bring into play the side to side movements of the head, the fore and aft paddling movements of the fore limbs and the synchronous movements of the hind legs, the natural inquiry would be: Is there provided a pathway from the reticular formation by means of which the impulses concerned in such a design might find eventual distribution to the muscles? A number of myelinized fibers may be observed making their way from the reticular formation of the mesencephalon in large sweeping arcs toward the midline where they

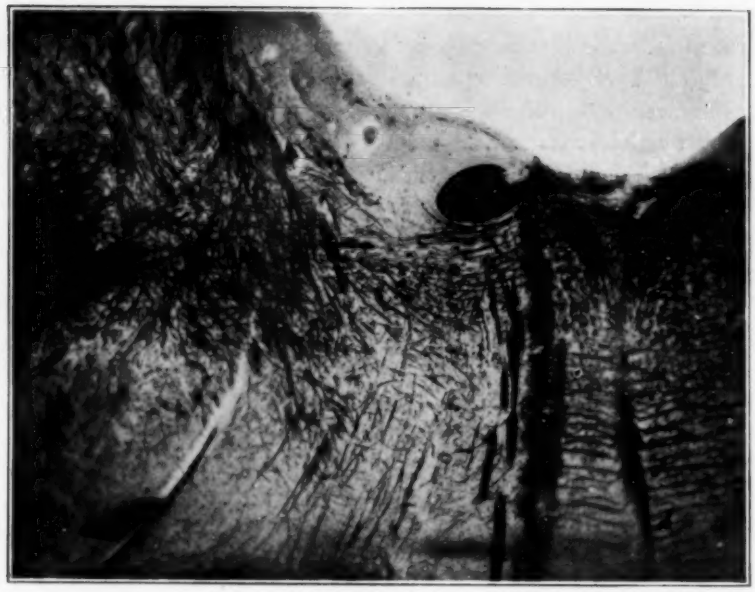

Fig. 8.—Section through Deiters' nucleus in the six-day old kitten, showing vestibular fibers entering the nucleus while juxtarestiform Deitero-spinal and Deitero-mesencephalic fibers are shown leaving it.

Fig. 9.—Section through Deiters' nucleus in a six-day old kitten, showing the Deitero-spinal fibers as they proceed obliquely from the nucleus toward the ventromesial area which they occupy in their descent.

cross to the opposite predorsal fasciculus in the commissure of Meynert. This fasciculus is usually regarded as a descending (efferent) bundle, and constitutes the ventromesial division of myelinized fibers already mentioned in the juxtaraphéal system. It seems probable that these are descending fibers because most of them decussate almost immediately after their appearance. This would hardly be the case in an ascending tract nearing its destination.

In searching for a myelinized system which might be presumed to convey both the afferent and efferent impulses necessary for the performances of the crawling-approach reaction, it seemed that vago-mesencephalic reticulopredorsal reflex fibers quite fully met the requirements. There were several reasons why it seemed necessary to call on some higher levels than the medulla oblongata in order to explain these relatively complex associated acts. For example, it was difficult in many particulars to reconcile the character of the approach movements with the more simple possibilities of motor control vested in the medulla. The opportunities for correlation here seem relatively scant as compared with other parts of the brain at higher levels; and hence the conclusion that the oblongata in all probability does not possess the coordination mechanism necessary to produce or control so complex a performance as the crawling-approach reaction. For this reason it was necessary to consider some other neuraxial region in which the function of correlation was preeminent, a region which, on the basis of experiment as well as comparative morphology, was known to regulate definite automatic associated movements. The grounds for selecting the reticular formation of the midbrain were suggested by a number of facts of a positive and certain others of a negative significance. The positive evidence has already been mentioned and discussed. Of equal importance in the selection of this area of the midbrain for the control of the movements in the crawling-approach reaction are the negative facts in the case. A strong argument in this connection was our inability to recognize any system of fibers with the slightest myelinization cephalad of the caudal limits of the superior colliculus. Not the slightest trace of myelinization could be detected in any fibers related to the more cephalic regions of the superior colliculus, to the thalamus or hypothalamus, to the basal ganglia or to the medullary substance of the cerebral hemisphere. This negative evidence was materially helpful in indicating the superior limits to which we might look in our search for a higher coordinating center for the crawling-approach reaction. The myelinized connections of this midbrain area emphasize the probability of its relation to this function. The afferent arm of this reflex arc through the midbrain comprises fibers from the stomach and intestine, through the dorsal vagal nuclei, into the juxtaraphéal fasciculi (ventro-

Fig. 10.—Section through Deiters' nucleus in the thirteen-day old kitten, showing the Deitero-spinal tracts passing ventromesially from the nucleus. The Deitero-mesencephalic fibers pass beneath the genu of the seventh nerve. Myelinized fibers occupying an extreme lateral position in the section are those of the vestibular division of the eighth nerve.

Fig. 11.—Section through the oblongata of the kitten at birth, showing myelinized fibers passing to the juxtaraphéal fasciculi from the dorsal vagal nucleus and the lateral reticular formation of the bulb. The myelinized emergent fibers of the hypoglossal nerve are also shown.

lateral division) to the reticular formation of the mesencephalon. The efferent arm is composed of the mesencephalic reticulospinal fibers passing downward and forming the ventromesial division of the juxtaraphéal system of fibers. In this reflex neural mechanism, there seems to be a satisfactory explanation of the central regulation involved in the crawling-approach reaction. A diagram indicating these connections is shown in Figure 18.

Although this mechanism may appear adequate in explaining how the approach reaction is determined, there now arises a problem in this connection of much greater difficulty; namely, what may be the source of adequate stimuli capable of determining the direction of the crawling-approach movements? It seemed reasonably certain that the special senses, such as vision, smell and taste, played little or no part in this important function. Stimuli arising in the olfactory sphere might be expected to contribute to this directive influence. But certain objections may be raised against this possibility. In the first place, there is no evidence of myelinization in the olfactory parts of the brain nor, for that matter, is there the slightest indication of myelinized fibers connecting the rhinencephalon with the lower segments of the axis. Careful search was made for indications of myelinization occupying the position of the fasciculus of Vicq d'Azyr, of the mammillo-interpeduncular fasciculus of Ganser, or of any other system connecting the mammillary bodies with the dorsal tegmental nuclei in the midbrain.

In addition to this morphologic evidence in the negative, certain experiments were performed on the young kitten immediately after birth which seemed to indicate that olfactory sensibility had not yet established itself and could not, therefore, be counted on as a factor in the directive influence over any motor activity.

Small,[18] some time ago, in studying the behavior of new-born rats, came to the conclusion that the olfactory sense was functionally active from the time of birth. We have repeated some of these experiments but could not convince ourselves that such is the case. Furthermore, the availability of the olfactory sense as a directive influence in motion would seem to presuppose a certain degree of olfactory experience which the new-born animal could not possibly possess. It is fair to presume that a number of olfactory stimuli might exist in the animal's environment at birth. Some of these stimuli would arise from sources connected with the mother, while others would originate from sources at some distance from her body. By what olfactory process not based on previous experience would the new-born kitten be led to select the stimuli arising from sources connected with the mother in preference to others? The existence of an instinctive olfactory pattern might, in the absence of actual associational experience, be urged to explain this

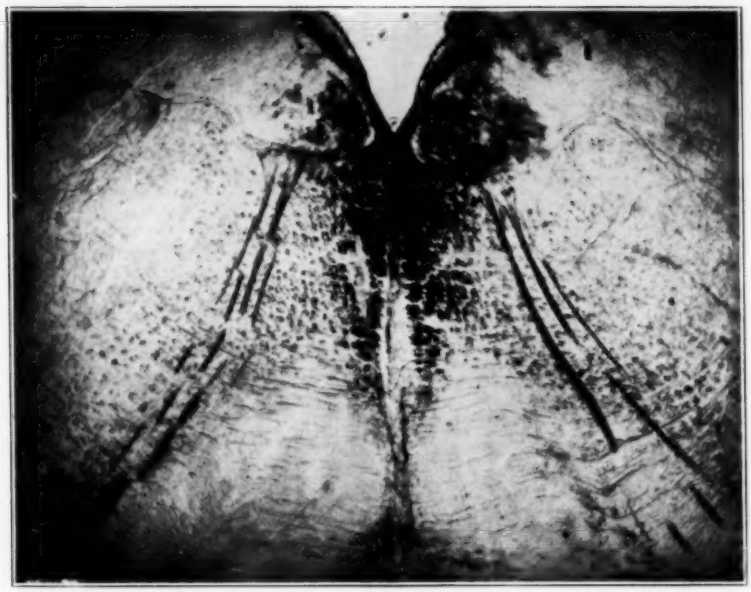

Fig. 12.—Section through the oblongata in a six-day old kitten, showing the relation of the juxtaraphéal fasciculi in their four divisions: (1) dorsomesial (posterior longitudinal fasciculus); (2) ventromesial (predorsal fasciculus); (3) dorsolateral (trigemino-mesencephalic fasciculus); (4) ventrolateral (vagomesencephalic fasciculus).

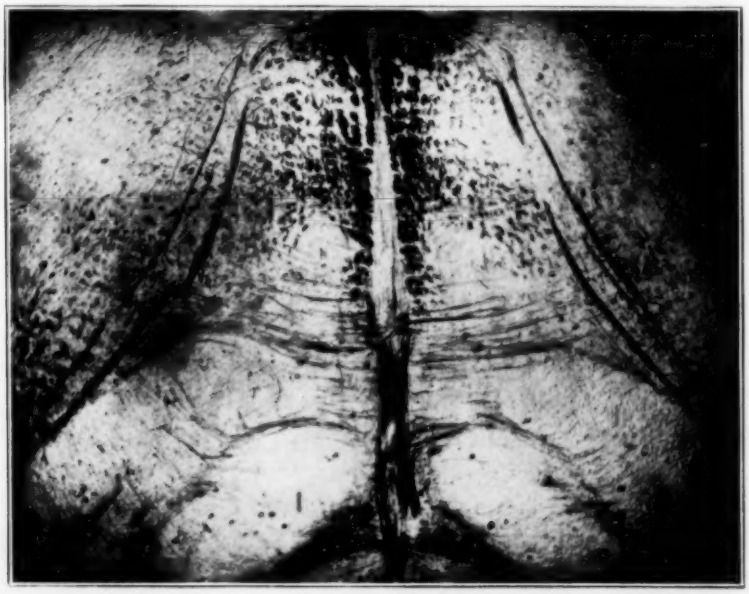

Fig. 13.—Section through the oblongata in a thirteen-day old kitten, showing the arrangement and relations of the juxtaraphéal fasciculi. The four divisions are well defined: (1) dorsomesial division (posterior longitudinal fasciculus—compact); (2) ventromesial division (predorsal fasciculus—compact); (3) dorsolateral division (trigemino-mesencephalic fasciculus—scattered); and (4) ventrolateral division (vagomesencephalic fasciculus—scattered).

selection. But this would appear to be an inexplicable prenatal conditioning of a special sense. Indeed, the relatively late maturity in the olfactory fiber system may be in the interest of retarding too rapid olfactory development until necessary associations have been established.

Vision also must be regarded as negligible in such directive capacity, as the upper eyelids are closed at birth and remain so for a number of days thereafter. In the matter of auditory sensibility, on the other hand, some question might be raised, since all of the cochlear fiber connections in the lower part of the brain-stem are myelinized at birth. This pathway may be considered open to stimuli serving in a directive capacity for the first movements of approach. The reconstruction of satisfactory auditory connections is illustrated in Figure 27. The same general objections might be advanced against the validity of auditory stimuli in the directive influence as in the case of the olfactory sense. There may, however, be some actual difference in these two instances in that no selection based on experience might be necessary in connection with auditory stimuli. The only sounds which could affect the cochlea of the new-born kitten are the purring of the mother or such noises as she makes in moving her body.

It also seems clear from the state of myelinization at this stage of development that little may be expected from general body sensibility. The dorsal columns are as yet unmyelinized, and hence impressions derived from the muscles, skin, joints, fascial planes and bones would not be available in the composition of the directive influences. One alternative seems to require further consideration. At birth and for some period before birth, the entire territory of the face, mouth and nasal cavity is well prepared for the receipt of sensory impulses. The peripheral trigeminal fibers and the spinal trigeminal tract are well myelinized at birth. Furthermore, a number of fibers arising from the substantia gelatinosa of Rolando may be traced in their course through the medulla. For the most part, these fibers cross the midline and take up a position in the ventrolateral division of the juxtaraphéal system (Figs. 19 and 20). Subsequent to crossing the raphé, the fibers turn cephalad to form an ascending bundle which may be distinguished from the posterior longitudinal fasciculus. This distinction depends on the less intense staining as well as on the less compact aggregation of those fibers which arise in the substantia gelatinosa as compared with those which constitute the mesial portion of the posterior longitudinal fasciculus. The fibers arising from the substantia gelatinosa constitute a secondary pathway for the conveyance of impulses from the territories of the face, mouth, tongue and nose. In addition to these fibers which ascend from the substantia gelatinosa, forming a secondary trigeminal pathway to the midbrain, other myelinized axons (Figs. 21 and 22)

Fig. 14.—Section through oblongata of kitten at birth, showing myelinized fibers from the formatio reticularis lateralis, from the dorsal vagus nucleus and some directly from the vagus nerve to the juxtaraphéal fasciculi.

Fig. 15.—Section through the oblongata of kitten at birth, showing secondary vagal fibers passing from the dorsal vagal nucleus, through the hypoglossal nucleus and into the juxtaraphéal fasciculi. Other myelinized fibers pass from the lateral reticular formation to the same destination. The fibers of the twelfth nerve are seen arising in the hypoglossal nucleus.

belonging to this system appear on the first day. They form the ascending mesencephalic division of the fifth nerve. This secondary trigeminal path may be traced up to the midbrain where collaterals from it ramify in the tegmental region. The lower levels of the brain-stem are thus connected with the midbrain by two important tracts on the first day, namely: the vagomesencephalic tract, and the trigeminomesencephalic tract.

The part which the first of these tracts plays in the conduction of impulses arising from the receptors of the stomach and intestinal canal has already been discussed, and its significance in the initiation of the crawling-approach reaction indicated. If the trigeminomesencephalic tract be accepted as valid, it may be employed in the explanation of the directive influence controlling the primitive crawling movements. It is evident that the somesthetic receptors of the face, mouth and nasal cavity are responsive at an early period to thermic stimuli, and the new-born kitten, being in proximity to the mother's body, may be influenced by heat stimuli from this source. The temperature of the air surrounding the kitten at birth would tend to be the warmest close to the mother. This would be the case with the domestic cat under the conditions of temperate climate. That the difference in temperature between the maternal body and surrounding air does exist in all instances which have come under our observation cannot be questioned. Furthermore, this difference appears to play some part in the composition of the directive influence controlling the early crawling reaction. The side to side movements of the head, already referred to as a component part in the crawling-approach reaction, produce an arc of nearly 90 degrees. In whatever position the kitten may be lying directly after birth, its head passing through this arc will encounter a temperature zone in which the air has been slightly raised by the presence of the mother's body. It is a fact of much interest in this connection that the sensory areas of the face invariably produce a reaction away from cold. A gentle draft of cold air on the kitten's face causes the animal at once to move its head away from the source of stimulus. If this cool draft impinges on the right side of the face, the head is turned to the left. If it strikes the left side, the movement is toward the right. If it stimulates the under surface of the jaw or throat, the head is moved backward, or if directly on the nose, the head is moved first to the right and then to the left in the evident attempt to escape the stimulus. Another test of the same character may be made by dipping the cat's head in cold or cool water. If the temperature of the water is much below that of the animal's head, it immediately moves away from the water in the same fashion as it moves from the cool air. This reaction occurs even when the introduction of the side, front or back of the head is made very slowly so that

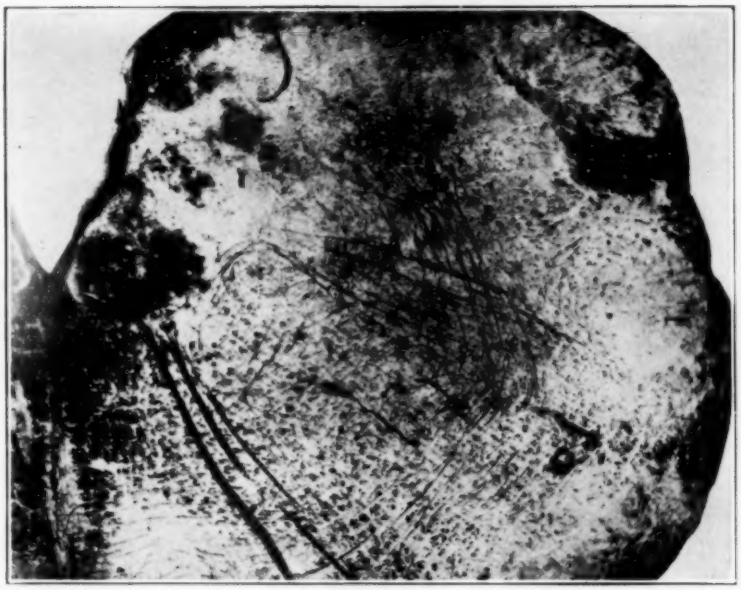

Fig. 16.—Section through the oblongata of a six-day old kitten, showing fine myelinized fibers arising in the substantia gelatinosa (secondary trigeminal fibers). Some of these fibers reach the ipsilateral and some the contralateral trigeminomesencephalic fasciculus.

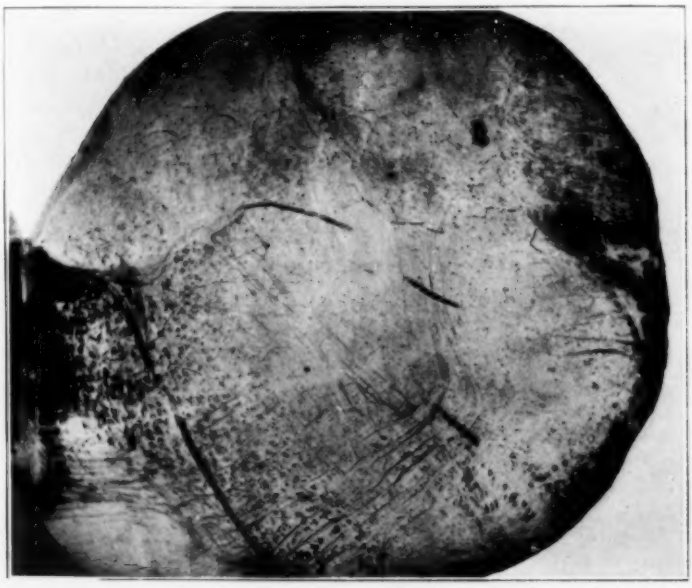

Fig. 17.—Section through the oblongata at the level of the hypoglossal nerve in the six-day old kitten, showing the several divisions of the juxtaraphéal system of fibers as myelinized at this time. The Deitero-spinal fibers are lateral to the emergent fibers of the hypoglossal nerve. Myelinized fibers from the lateral reticular formation and the dorsal vagal nucleus are also well shown.

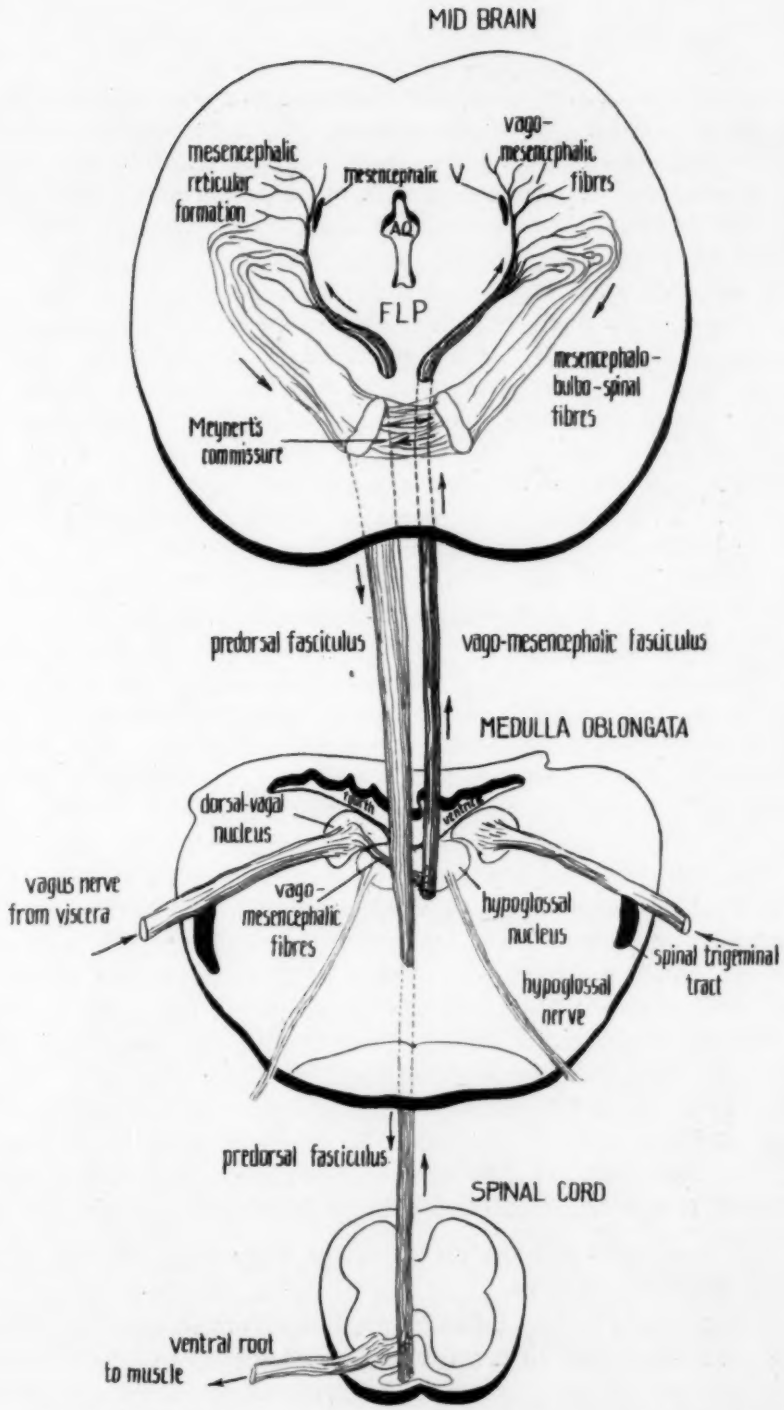

Fig. 18.—Diagram made from a graphic reconstruction of the kitten's brain-stem at birth, showing the afferent and efferent arms of the reflex arc which controls the crawling-approach reaction. The stomach and small intestine appear to be the chief sources of sensory stimuli by way of the vagal innervation.

the elements of sensory stimulation due to contact with a fluid surface may be minimized. When warm water near the temperature of the body of the mother is employed, the resulting reaction is very much less constant and also less extensive in the degree of motion produced. It seems probable that temperature stimuli impinging on the head and face as the result of the warming of the air caused by the mother's body, may have a directive influence on the crawling movements.

Not only is the surface of the head capable of responding to sensory impressions, but the inhaled air, passing as it does over the mucous membrane of the mouth and nose, likewise contributes its quota of thermic stimulation. The determination of a directive influence in consequence of thermic stimuli might be conceived of in the following manner: First, the early movements of the head from side to side alternately bring the head into zones on either side in which coolness acts as a stimulating factor, while somewhere between these extreme limits, there is an intermediate warm zone which would establish, as it were, a line of least resistance, thus favoring an approach toward, rather than away from, the mother. That some such factor must be operative was made clear by placing a cat's skin which had been refrigerated for a number of hours over the mother's body. In the test, the new-born kitten moving its head from side to side in the characteristic manner never selected a course of approach which would lead it to the mother but, after some hesitation, it usually moved in the opposite direction. When, however, the refrigerated cat's skin was removed and the kitten replaced in its original position, it very soon determined the proper course toward the mother and in the average length of time reached her body, secured the nipple and was nursing. This experiment was repeated a number of times, but always with the same results in the case of each new-born kitten in the litter.

Although this interpretation may make the directive influence appear to be a heat-attraction phenomenon (thermotropic), it is really such only so far as the animal is positively reacting against the effects of cold stimuli and thus seems to be attracted by stimuli of warmth. In whatever way these primitive crawling-approach movements may be finally explained, two fundamental elements must be recognized in them:

1. The initiation and persistence of the movements until the goal of their purpose is attained.

2. A sensory directing influence which renders this goal attainable.

Each of these two elements should, *a priori*, depend on a definite neural mechanism. Concerning the intimate relation of these elements in the crawling-approach reaction, we have questioned whether they were intrinsic parts of one and the same motor performance. We have been forced to conclude that such is not the case and that they are

inherently dependent on different neural arcs so far as their afferent pathways at least are concerned. That they are cooperative in a special reaction there can be no doubt. But quite as certainly they are separable when this specific reaction is not the chief concern of the animal. For example, when we placed a new-born kitten in a large vessel of water, it immediately began to make effective swimming movements with its fore and hind limbs. These movements were distinctly of the paddling variety, similar to those observed in the early crawling-approach reaction. They were synchronized in the same manner and resulted in moving the animal head first through the water. During this swimming performance there were no side to side (lateral cephalogyric) movements of the head. In fact, there was no movement of the head of any kind after the animal began to swim. On touching the water the kitten at once extended its head in such a manner as to lift the mouth, chin and throat away from the water's surface. Irrespective of the temperature, the head maintained this extension with the apparent purpose of keeping the muzzle above water.

The side to side movements of the head, while evidently separable from the paddling movements of limbs, should nevertheless be regarded as essential elements in the crawling-approach reaction. They not only make possible a directive influence in the motions performed as a result of thermic stimuli, but by bringing first one ear and then the other in line with the mother, add the directing effect of the auditory stimuli produced by the mother's purring. The provisions made by means of myelinized fibers for the introduction of these directive influences are shown in Figures 23 and 24.

The principal factors, therefore, in the crawling-approach reaction are, first, the stimuli from the stomach and intestines which initiate the side to side movements of the head together with the paddling movements of the limbs, and, second, the thermic and auditory stimuli which give direction to these approach movements.

Although this explanation of the second behavioral component is generally satisfactory on the basis of neural organization, we are not inclined to overlook another interpretation concerning the possible genesis of the approach reaction. The new circulatory conditions established after birth by the discontinuance of placental circulation produce new hemal conditions. Such alterations in blood might conceivably act on certain parts of the nervous system in such a manner as to determine all of the associated movements in the crawling-approach reaction. This conception of the genesis of these movements is of course dependent on chemical activation of certain neural reactions. It does not involve the necessity of establishing the complete reflex mechanisms for the consummation of reactions and is a possibility of profound significance as bearing on the development of other functions.

There seems to be little doubt that respiration is a function in part or as a whole determined by chemical changes in the blood. While a complete reflex mechanism may be necessary to the proper regulation of this function, the essential impulses to the respiratory act are derived from chemical sources. The venosity of the blood is the prime factor in the intiation and maintenance of respiratory action. Not only does this condition of the blood determine the muscular activities requisite to normal respiration, but it is also capable of extending its influence far beyond this limited muscular territory. Under circumstances in which the animal is deprived of proper aeration of the lung with the constantly rising carbon dioxid content in the blood, more and more muscles of the body are brought into action in order to obtain air, even to the extent of producing a generalized convulsion. Here, therefore, a chemical condition in the blood is the determining factor in the production of effector impulses not necessarily limited to the respiratory muscles, but capable of spreading to the entire somatic musculature. If a chemical source of stimulation is capable of affecting so fundamental a mechanism as respiration, the precedent is clearly established that similar or parallel chemical processes may have validity in initiating the movements of other performances. In this case it is conceivable that the blood changes occasioned by the cessation of placental circulation might be effective in stimulating those parts of the brain which control the simple associated movements combined in the crawling-approach reaction.

One objection to accepting this view, however, is the difficulty which it creates in drawing a line between the chemically determined reaction and the reaction due to the more usual receipt of peripheral stimulation by specialized receptors.

Experimental investigation aimed to block the afferent vagal paths from the stomach and intestines may subsequently establish the grounds for identifying a peripheral source of adequate stimuli for the crawling-approach reaction, as well as a chemical source in the blood. Certainly, in other functions such as the development of sexual activity, it seems probable that some form of chemical stimulation must contribute to the reactions. In this light a dual participation in which both types of stimulation contribute to the reactions should not be overlooked. The chemical factor would in this sense act by increasing the state of irritability in the nerve centers so that afferent impulses arising from stimuli received by specialized receptors might affect aggregations of nerve cells thus prepared in advance to give more complete and satisfactory effector response. This participation of nerve-born impulse and blood-born activation is a problem which deserves more careful and extended consideration.

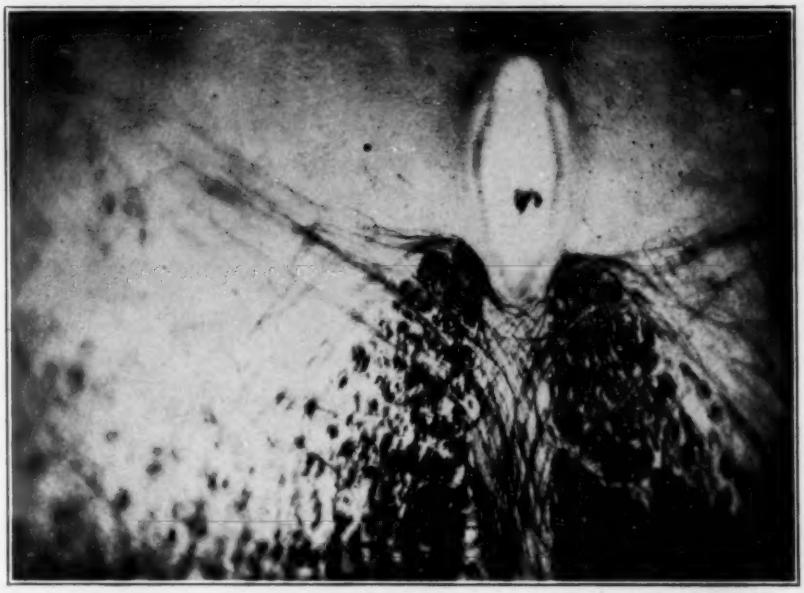

Fig. 19.—Section through the oblongata of the kitten at birth at a level immediately caudal to the obex, showing decussating fibers from the dorsal vagal nucleus entering the juxtaraphéal fasciculi. The heavily myelinized bundles belong to the posterior longitudinal fasciculus.

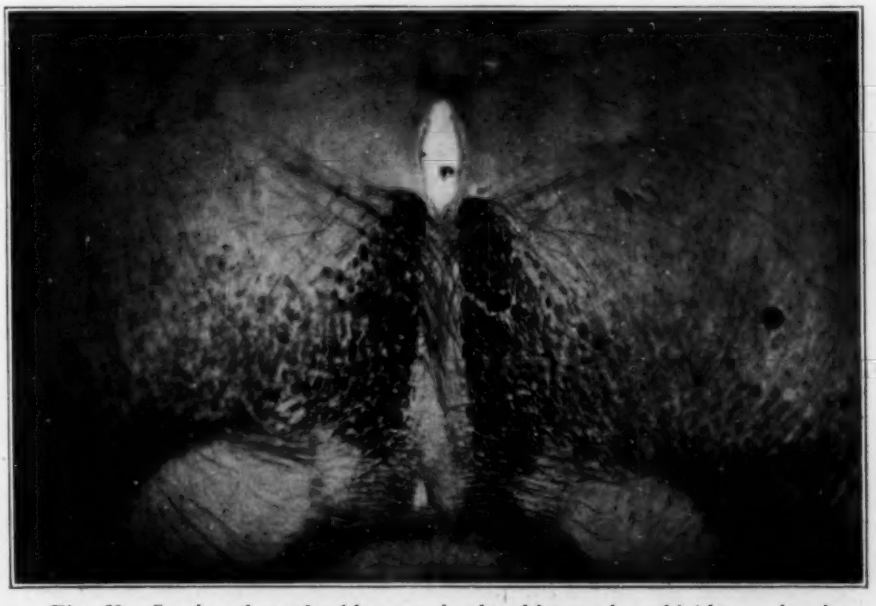

Fig. 20.—Section through oblongata in the thirteen-day old kitten, showing the decussation of fibers which enter the juxtaraphéal fasciculi. These fibers arise in the caudal extremity of the dorsal vagal nucleus.

ANALYSIS OF THE SUCKING REACTION

The third component of behavior makes its appearance on the average of from ten to twelve minutes after birth. It consists of a series of movements necessary to finding and taking the nipple into the mouth, together with the acts of sucking and swallowing and certain movements of the fore and hind limbs. Although apparently simple, the sucking reaction presents several difficult problems, first, with reference to the factors which determine and guide the quest for the nipple, and second, concerning the equally important factors which cause the nipple to be secured when it is ultimately found.

When the young animal reaches the mother, its muzzle, particularly the nose and lips, comes into contact with the soft, short, ventro-abdominal fur surrounding the areolar line. This fur differs from that of the immediately adjacent skin in its finer and softer quality. It has none of the bristle-like texture of the hair on the flanks and back. The areolar area about each nipple is roughly circular, with a diameter of approximately 1 inch (2.5 cm.). The fine hair on the abdominal wall ceases as this areolar area is reached. Only its outermost circumference is hair-bearing, the remainder being quite free from hairs. After reaching the mother's body, the side to side (lateral cephalogyric) movements of the kitten continue and, as a result, the nose and lips are rubbed across the abdominal wall. This movement continues for several minutes so that each oscillation of the head brings the lips in closer proximity to the nipple. The directing influence in shortening these oscillations seems to be the varying degrees of coarseness of the hair surrounding the areola. By means of this concentric diminution in radius of motion the lips are brought in final contact with the nipple, and the latter being in an erectile state, stimulates the labial and lingual mucosa. This stimulation causes closure of the mouth and grasping of the nipple. That the directing influence which finally determines the taking of the nipple arises from sensory impulses conveyed by the fifth nerve, is advanced with all the more confidence because, as already shown, no other sense organs except those of the trigeminal group are capable of this particular conduction. With one possible exception, namely, that of taste, it seems probable that none of the special senses is here involved. Vision is not functionally active at this period. Hearing cannot conceivably play a part in the composition of this directive influence, and olfactory sensibility is probably out of the question, on grounds already discussed. Gustatory sense remains to be considered and offers the possibility that the function of taste may be operative as myelinized fibers are present in relation with the nucleus of the fasciculus solitarius.

Fig. 21.—Section through the oblongata in the kitten at birth, showing the myelinization in the descending spinal tract of the trigeminal nerve. No myelinized fibers are present in the circumferential zone later to be occupied by the ascending cerebellar tracts. Some myelinized fibers of the secondary trigeminal tracts are shown emerging from the substantia gelatinosa.

Fig. 22.—Section through the oblongata at the level of the hypoglossal nucleus in the kitten at birth, showing myelinized fibers arising from the substantia gelaninosa and passing to the juxtaraphéal fasciculi (secondary trigeminal fibers). The fibers of largest caliber belong to the vagus nerve.

Certain objections may be advanced against the gustatory sense as a directing influence in the movements necessary to securing the nipple. This sense requires stimulation by actual contact. Such a contact between the taste-buds occupying the anterior two thirds of the tongue and the nipple would be difficult during the side to side movement of the head across the mother's abdominal wall unless the tongue were protruded during this act. We have observed no such protrusion of the tongue. The only other possibility which would permit participation of the gustatory sense in the directive influence resulting in the finding of the nipple, would be the existence of taste-buds on the lips. We have not made search for these organs in the young kitten, but their absence in the adult animal would favor the belief that they do not exist in the earlier stages of development.

The foregoing objections to all of the special senses in their relation to this specific directive influence of the sucking reaction compel the conclusion that the main and probably the only source of sensory stimuli for directing the side to side oscillations of the head must be referred to the trigeminal innervation. Certain experiments made this conclusion seem more convincing. For example, the nipple was painted with a solution of quinia, notwithstanding which the kitten secured it without apparent objection. The nipple was also painted with ether and the ether allowed to evaporate in the belief that certain fatty substances might be important in determining the selection, but here again no variation in the act was observed. The nipple was then painted with petrolatum, but the kitten found and attained its goal as usual. Finally, a coating of celloidin was applied to the nipple, causing it to shrink or lose its erectile character. Under these circumstances alone was the kitten unable to make the proper connection.

After securing the nipple, which is accomplished by the closure of the lips, sucking begins. The act of closing the lips and approximating the lower to the upper jaw has its adequate stimulus in the pressure of the nipple on the labial and lingual mucous membrane. This tactile stimulus would be conveyed by means of the trigeminal nerve fibers to the sensory receiving nucleus of the fifth nerve in the bulb. The substantia gelatinosa of Rolando at this stage has many myelinized fibers connecting it with the hypoglossal nucleus, the nucleus facialis, the nucleus of the vagus and glossopharyngeal nerves as well as its own intrinsic motor nucleus, the nucleus masticatorius. Such tactile stimulation arising in the buccal cavity would thus undergo the conversion necessary to close the mouth for sucking, an act which includes the approximation of the lower to the upper jaw, the contraction of the cheeks to obliterate the oral vestibule, the elevation of the soft palate to occlude the posterior nares and the pressure upward of the tongue

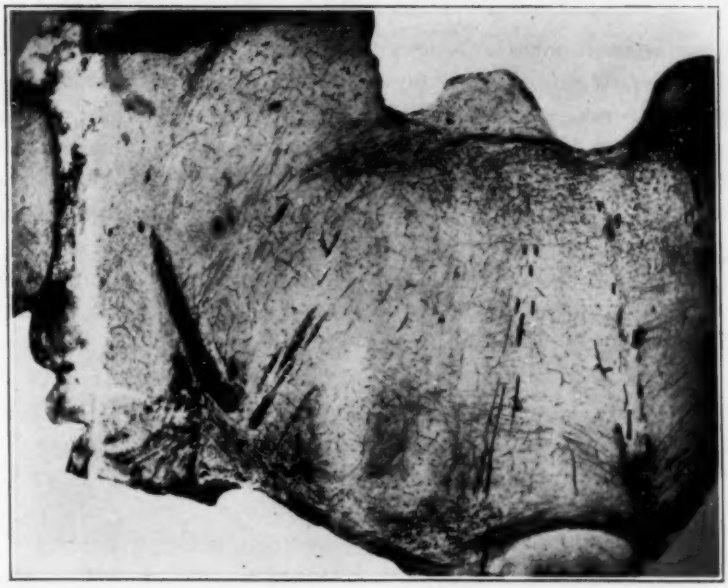

Fig. 23.—Section through the level of the superior olive in the kitten at birth, showing myelinized cochlear fibers in their decussation. The fibers of the sixth, seventh and vestibular division of the eighth cranial nerves are also shown. The descending trigeminal tract is especially prominent at this level.

Fig. 24.—Section through the superior olive in the kitten at birth, showing the myelinized fibers forming the trapezoid body and undergoing decussation.

against the hard palate. This reflexly determined act has the secondary effect of causing the milk to flow into the mouth, the presence of which serves as an adequate stimulus for determining the act of swallowing. Here again the adequate stimulus of the milk in the mouth is provided proper afferent conduction by the fifth nerve. This part of the suctorial activity, namely deglutition, continues until sufficient fluid has entered the stomach to fill and distend it, thereby causing cessation of its peristaltic movement. At this phase in the sucking reaction, swallowing ceases and the grasp on the nipple is more or less relinquished, although the kitten often retains the nipple in the mouth after it has ceased to nurse and has apparently fallen asleep. The muscular tension at this time, however, is quite tenuous, and the kitten may be detached by gently withdrawing its body from the mother. When, however, it is actively nursing, it holds on with considerable tenacity, even when some force is exerted to separate it from the nipple.

The sucking and swallowing movements are not the only motor activities in the suctorial reaction. During the entire performance, the two fore limbs move alternately, first the right and then the left, pressing against the breast in such a way that one fore paw and then the other brings pressure to bear on the area about the mamma. In time and rhythm these movements of the forelimbs are not unlike the primitive paddling movements of the crawling-approach reaction. They are perhaps slightly more rapid and less in their excursions. They are produced largely by the action of the extensor groups, whereas the paddling movements are produced chiefly under the influence of the latissimus dorsi in their backward sweep and the pectoral muscles in their forward sweep. Neither of the last named muscles is motofacient, that is, produces movement, during the suctorial reaction. The movements of the fore limbs during nursing have been interpreted as having a pressor effect in kneading or stripping the mamma. In the hind limbs there are also slow, synchronous movements similar to those seen in the crawling-approach reaction, except that they are somewhat less forceful. They are also less regular in rhythm and excursion. Their apparent purpose is to hold the kitten's body against that of the mother while it is nursing. These two groups of movements in the extremities represent the activity of a neural mechanism essentially similar to that discussed in connection with the crawling-approach reaction. It is interesting to note, however, that on reaching the mother's body the crawling-approach reaction as such ceases, although many of the integral muscular acts comprising it continue with certain modifications. This modified continuance of motion in the extremities during the sucking reaction may be designated the *leg-pressor movements of sucking.*

The neural mechanism provided for the movements of the crawling-approach reaction should suffice for the performance of the pressor-leg movements. Adequate afferent stimuli for the continuance of the latter movements during the entire period of nursing could take origin in the gastro-intestinal tract, the peristaltic contractions of which persist until the stomach is distended by ingested fluid. Under such circumstances, the vagus would carry the stimuli inward to the vagal nucleus in the medulla. Thence the same vagomesencephalic path utilized for the afferent stimuli in the interest of the crawling-approach reaction

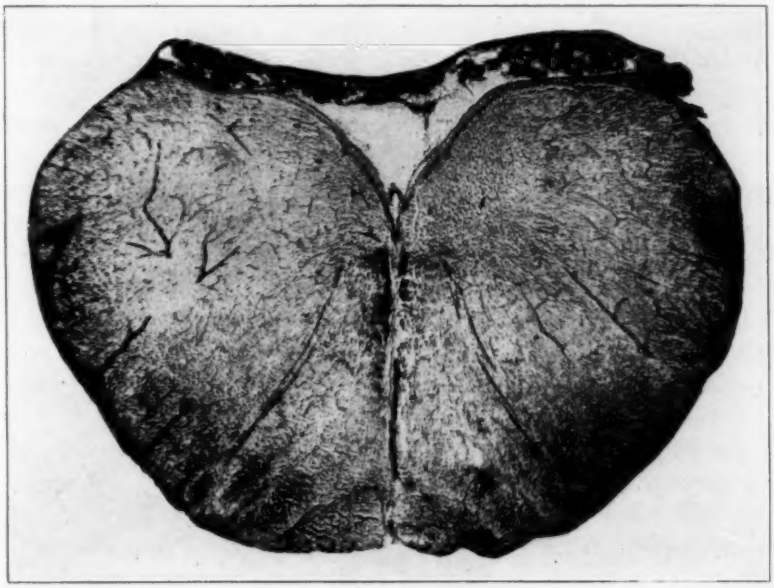

Fig. 25.—Cross section through the oblongata in the kitten at birth, showing myelinization only in the juxtaraphéal, descending trigeminal and Deitero-spinal fibers.

would convey the impulse to the midbrain and there elicit effector response necessary to the pressor reaction. It is significant that the movements of the fore and hind limbs gradually become less pronounced as the stomach becomes more completely filled. It is also a matter of interest that the delivery of the effector response requires no other pathway than that already provided by myelinization in the predorsal bundle. The question, however, might be raised, how the same neural mechanism produced responses which are so dissimilar in their ultimate effects. The paddling movements of the crawling-approach reaction are evidently quite different in many respects from the pressor movements.

On the other hand, the object in both of these reactions is identical; namely, performances essential to the obtaining of food supply. From this point of view, it is reasonable to assume that the motor responses elicited in behalf of this object would not cease until that purpose was fully served. The actual attachment to the mother's nipple at once obviates the necessity of further crawling or cephalogyric motions. Both the head and the body of the kitten become fixed in their spatial relations when the suctorial act begins. Nevertheless, the source of the afferent stimuli for the movements essential to the crawling-approach reaction, as well as the sucking reaction, still remains active. The stomach is yet unfilled and continues to send impulses to the vagal territory. Not until these impulses cease to flow does the entire motor response disappear. As might be expected, some motor residue of the crawling-approach reaction persists even after the young animal has become attached to the mother and actual crawling is no longer necessary. The transitional modifications of the crawling reaction would thus be represented by residual movements adapted and determined by the motor complexes of sucking and swallowing. In this way the difficulties of explaining the pressor movements of the limbs during nursing seem to disappear. These movements may be regarded as having the same source of stimulation, the same neural mechanism in conduction, conversion and distribution, differing only in their purpose because their action has been modified by the requirements of suctorial function and deglutition.

After the kitten has ceased nursing, the pressor movements of the fore limbs and hind limbs are discontinued. In most instances, the kitten relinquishes its grasp on the nipple and slips down beside the mother's body. It remains in this position for some time until it again manifests evidences of hunger and exhibits the complete cycle of motor activities by which the stomach is refilled. During the period while it lies quiescent, it gives no sign of somatic efforts. Now and again its body musculature produces slight irregular twitchings sufficient perhaps to move one limb, turn the head or even to give a short convulsive twist to the entire body. But these muscular movements are instantaneous and do not effect a change in the animal's position nor produce purposive movements. Such irregular twitchings bear a close resemblance in time and rhythm to the short, sharp movements which may be observed in the animal by palpation before birth. Thus when the new impulses from the stomach and intestines subside, the animal lapses back into a condition which, with the exception of respiration, is essentially that of intra-uterine life.

The sucking reaction which must be regarded as an unlearned reaction, consists of certain essential movements which may be summarized as follows:

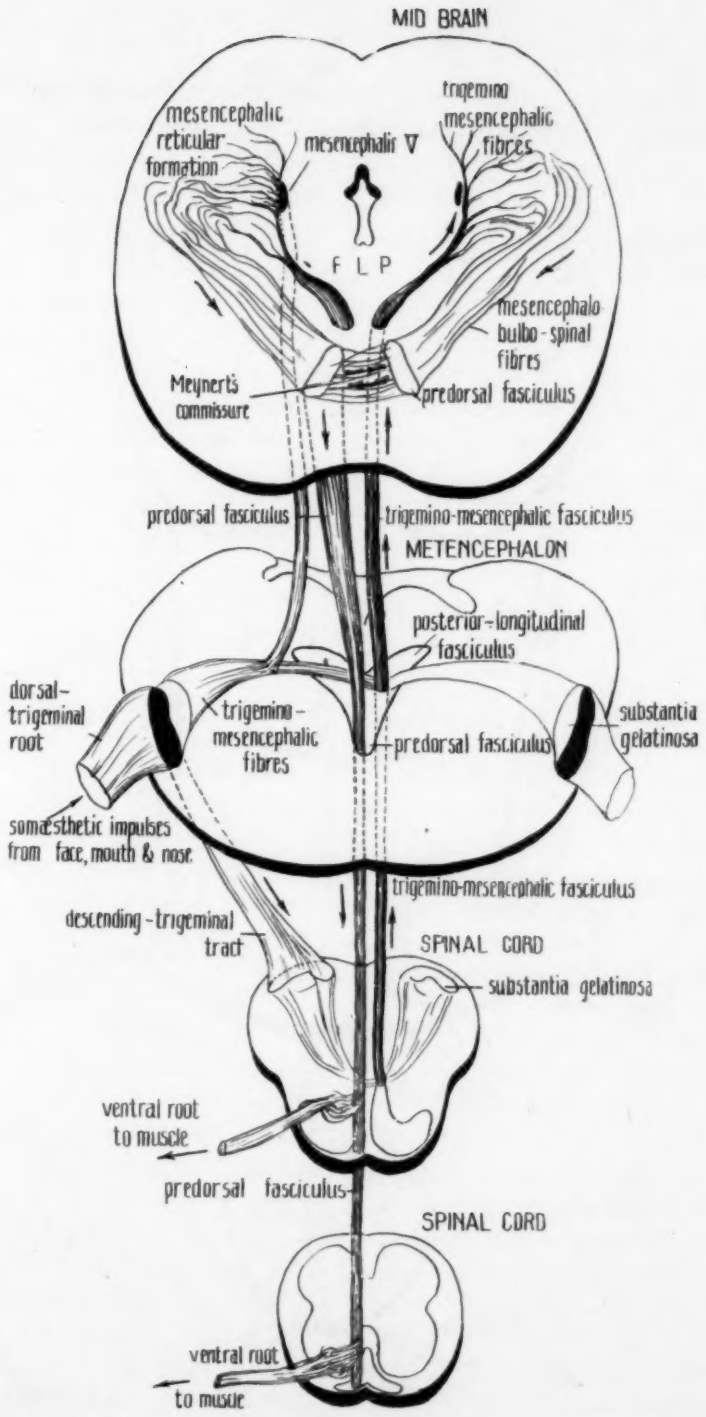

Fig. 26.—Diagram made from a graphic reconstruction of a kitten's brain-stem at birth, showing the afferent and efferent arms of the reflx arc which supplies the directive influence to the crawling-approach reaction. The trigeminal innervation appears to be the chief source of sensory stimuli.

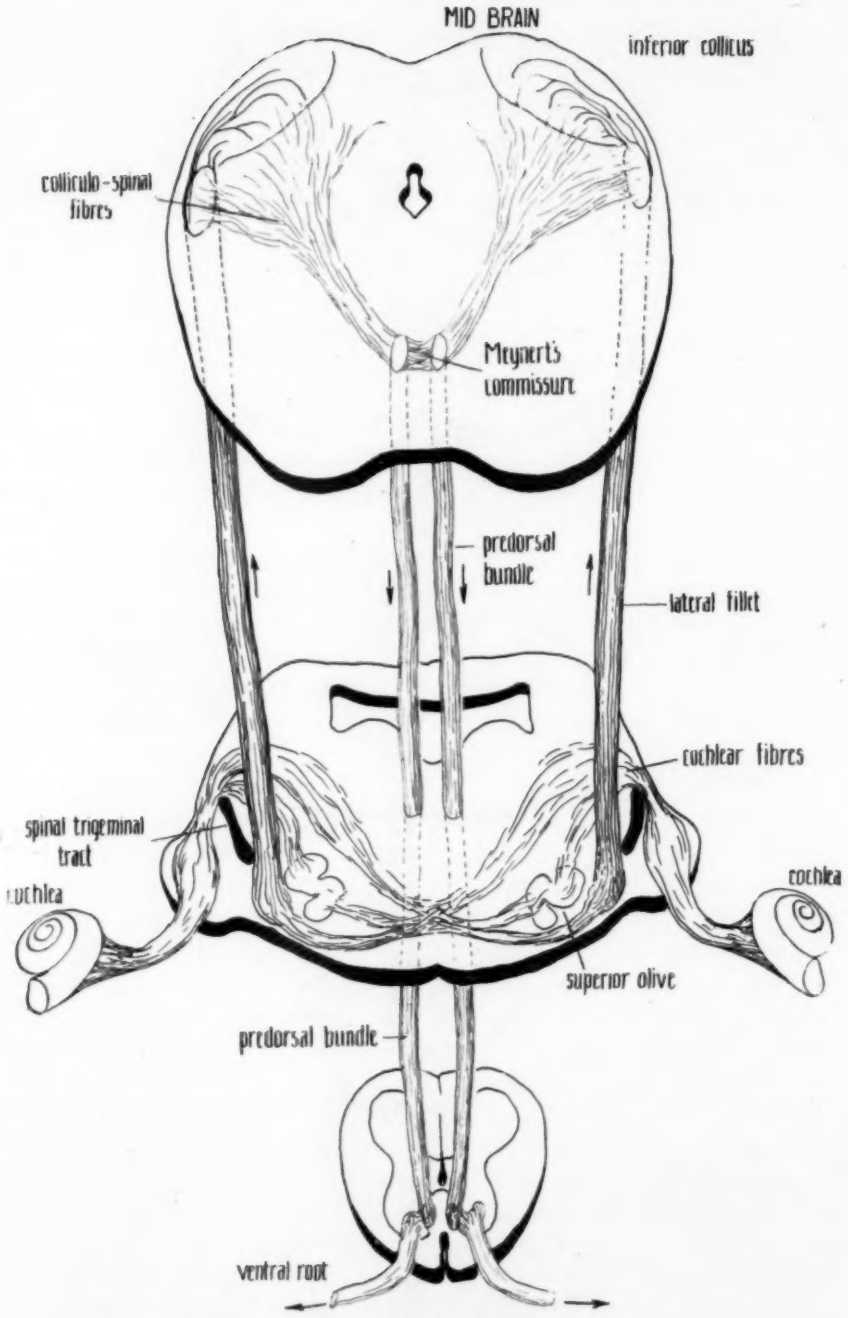

Fig. 27.—Diagram made from a graphic reconstruction of a kitten's brain-stem at birth, showing the afferent and efferent arms of the reflex arc concerned in introducing auditory stimuli as factors in the directive influence of the early movements of the animal.

1. Movements in seeking the nipple.

2. Movements in grasping the nipple by closure of the mouth which result in sucking.

3. Movements in swallowing.

4. Movements of the hind and fore limbs—pressor movements.

There may be some question whether it is necessary to assume a control from some higher correlating center to regulate the sucking reaction, or whether it is sufficient to regard this performance as the specific motor output of such correlation as may take place between the bulbar nuclei. While the sucking reaction in the strict sense is a mammalian acquisition, its individual components have a great phyletic antiquity. It seems plausible to presume that a low associative organization of such phyletically constant factors as swallowing and mastication might easily be provided through the bulbar segments of the brain-stem without the intervention of higher segments. If, however, the association of so many component acts in the mammalian sucking reaction is considered too complex to permit so simple an interpretation, the connection with the midbrain by myelinized fibers in the cat at birth would satisfy the conditions necessary to a mesencephalic regulation of sucking.

All of the performances thus far analyzed represent the unlearned reactions of the young kitten in the first day of life. These reactions should be considered unlearned because, so far as may be positively determined, they have not heretofore constituted a part of the animal's experience. Under observation they were performed for the first time for the achievement of a specific purpose. Undoubtedly they have all of the characteristics of what have been called *instinctive reactions*. But even if this designation is still acceptable, it must be conceded that it affords no explanation of the reactions themselves. At best it implies that certain performances naturally take place without any apparent opportunity for the animal to learn them, and that these performances seem to be inherent parts of the animal's behavior based on its phyletic heritage. We would hesitate to accept the term instinctive, or any other term as applied to these early acts, which does not recognize the further necessity of interpreting such reactions in terms of stimuli received and responses produced. The unlearned behavioral reactions of the kitten on the first day are: (1) the postural reaction; (2) the crawling-approach reaction, and (3) the sucking reaction.

The nerve fibers myelinized at birth in the kitten may be summarized as follows:

1. Ventral root fibers of all the cranial and spinal nerves. This provides connection between the motor nuclei and the somatic effectors.

2. The dorsal root fibers of all the spinal and cranial nerves, thus providing for immediate reflex reaction at all axial levels. There is, however, but scant myelinization of the dorsal columns in the higher cervical levels and no deposition of myelin in the corresponding areas of the medulla at birth.

3. The posterior longitudinal fasciculus is heavily myelinized and thus stands out in marked contrast to the surrounding unmyelinized areas. It extends, in part at least, from the posterior commissure in the midbrain to the lower sacral segments of the cord. This bundle, we believe, comprises the elements already ascribed to it by Cajal, i. e., ascending and descending fibers. Its ascending fibers are grouped thus: (*a*) Deitero-mesencephalic fibers; (*b*) trigeminomesencephalic fibers, and (*c*) bulbar reticulomesencephalic fibers.

To the latter group we would add certain vagal elements which we have clearly discerned as they join the reticular contingent in the bulb while these fibers are making their course dorsomesially from the reticular formation. We are in general accord with Mussen's [16] interpretation of this primitive bundle with reference to the descending fibers which seem to occupy the more mesial portions of the fasciculus and comprise the following groups: (*a*) commissuro-bulbo-spinal fibers which arise probably in the nucleus of the posterior commissure; (*b*) interstitiospinal fibers which probably arise in the interstitial nucelus of Cajal.

The significance of the early ascending connection created by the fasciculus longitudinalis is not primarily the introduction of vestibulbar influence for controlling eye movements in the interest of equilibration, although this influence ultimately must be of supreme importance. It can, however, play but a small rôle in the young kitten whose eyes are still closed. Indeed, it cannot have much bearing in this vestibulo-oculomotor capacity in such animals for example as the mole, in which there is neither trochlear nor oculomotor nucleus; although, according to Forel, the fasciculus itself is well defined. These facts are sufficient to indicate that the early ascending connections of the bundle are not essentially vestibulo-oculomotor. The primitive vestibular connections with the midbrain would, however, serve a real purpose in bringing the impulses concerned in the vertebrate posture into combination with afferent impulses from other sources such as the trigeminal and vagal territories. By this means, correlation of afferent impulses might be determined to activate the associated movements of early life.

While this investigation does not deal directly with the questions primarily involved in the fiber constituency of the fasciculus longitudinalis posterior, nor could the method of approach be considered adequate to that problem, nevertheless it has supplied some collateral evidence in this regard. We are of the opinion that a certain portion of

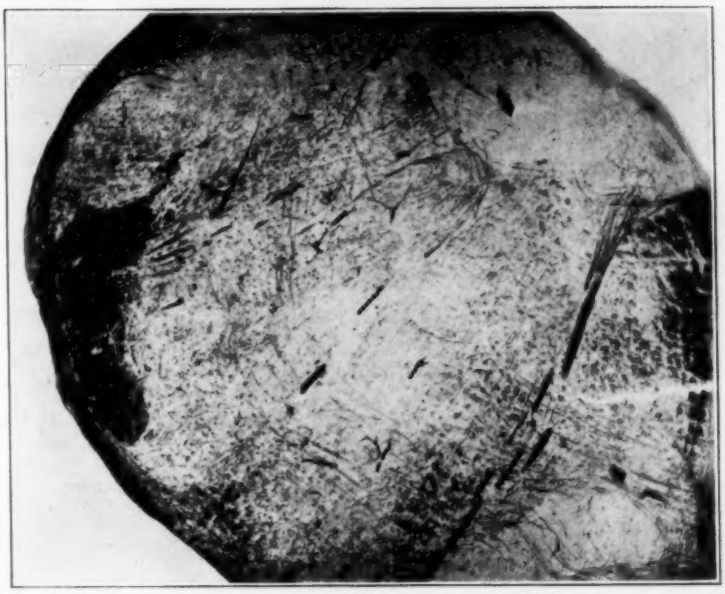

Fig. 28.—Section through the oblongata of a six-day old kitten, showing accessions in myelinized fibers in the ventral and dorsal spinocerebellar tracts, rubrospinal and spinothalamic tracts. The heavier myelinization in the descending trigeminal tract is notable in comparison with those systems more recently myelinized.

Fig. 29.—Section through the midbrain of the six-day old kitten, showing the myelinized fibers constituting the decussation of the superior cerebellar peduncle, the posterior longitudinal fasciculus, the predorsal bundle and the rubrospinal tract.

the ascending fibers establish connection with the midbrain in the reticular formation, especially in the region of the inferior colliculus, thus bringing the vagal, trigeminal and vestibular territories into early communication with the mesencephalon. In addition to these vago-mesencephalic, trigeminomesencephalic and vestibulomesencephalic fibers, there may be some descending fibers arising in the collicular region, as Mayser [12] originally thought. It is possible that such axons take origin in the large cells between the posterior commissure and the oculomotor nucleus, while others arise in the nucleus of the posterior commissure and interstitial nucleus of Cajal.

4. The predorsal fasciculus consisting at first almost exclusively of descending fibers which arise in the mesencephalic reticular formation, in close proximity to the endings of the vagomesencephalic fibers. The axons may at this stage be referred to as colliculo-bulbo-spinal. Later they are augmented by tectospinal fibers. Their course at first takes them horizontally in sweeping curves forward and inward through the tegmentum mesencephali until they cross the midline to form the well marked dorsal decussation of Meynert. Subsequent to decussation, they occupy a position on either side of the raphé ventral to the posterior longitudinal fasciculus. It has been presumed that these are descending fibers because of their almost immediate decussation after appearing in the midbrain. They constitute an important bundle by providing efferent tracts for impulses arising in the collicular region (Figs. 30, 31 and 32).

5. The descending tract (spinal) of the trigeminal nerve is well myelinized at birth. Myelinized fibers may be discerned connecting the substantia gelatinosa with the hypoglossal nucleus, vagal nucleus and facial nucleus. Other myelinized fibers from this source form the trigeminomesencephalic tract. These ascending fibers have long been known to exist and are described by Cajal, Déjerine and others. They form the dorsolateral portion of the juxta-raphéal system of fibers and occupy an area in the bulb ventral to the nucleus hypoglossi. The fibers of the mesencephalic tract of the trigeminal nerve are also myelinized at birth.

6. The Deitero-spinal fibers which constitute two tracts passing into the spinal cord from the nucleus of Deiters. One of these tracts is ipsilateral and the other contralateral. In the medulla, these tracts occupy a position lateral to the emergent hypoglossal fibers and immediately dorsal to the inferior olive.

7. At birth, the fibers of the acoustic system are myelinized and may be traced in the lateral fillet as far cephalad as the inferior colliculus.

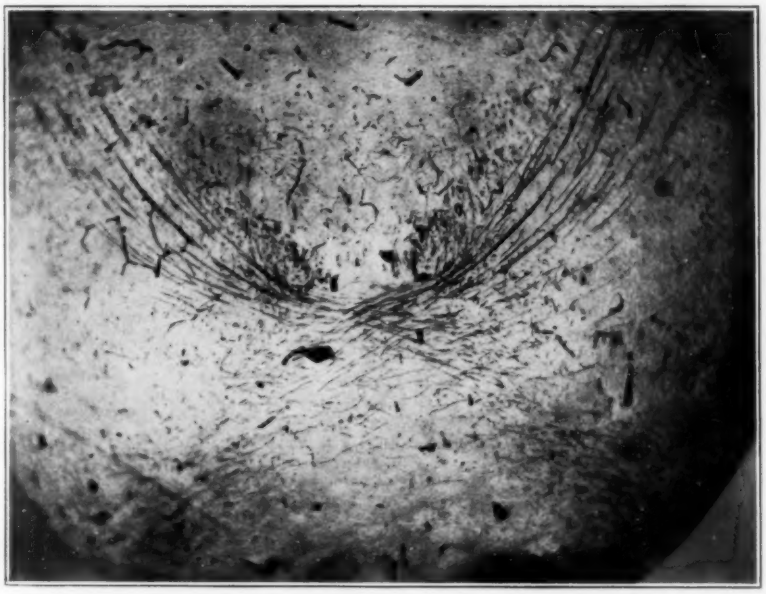

Fig. 30.—Section through the midbrain of a kitten at birth, showing the myelinized fibers in the posterior longitudinal fasciculus, the mesencephalic decussation of Meynert and the beginnings of the predorsal fasciculus.

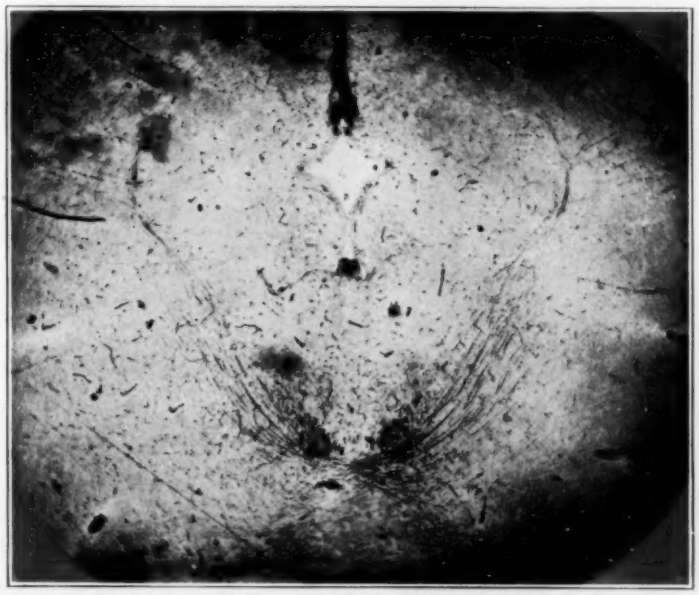

Fig. 31.—Section through the midbrain of a kitten at birth, showing myelinized mesencephalic reticular fibers which undergo crossing in Meynert's mesencephalic decussation, also the posterior longitudinal fasciculus, predorsal bundle and ascending mesencephalic root of the fifth nerve.

An illustration of a cross section through the oblongata at the level of the inferior olive in the kitten at birth is shown in Figure 25. It indicates how limited and scattered are the areas of myelinization at this time. Yet, on the basis of these limited systems of myelin mature fibers, we believe it possible to explain all of the behavioral reactions observed during the first day of the animal's life.

THE NEURAL MECHANISM INVOLVED IN THE BEHAVIORAL REACTIONS OF THE KITTEN ON THE FIRST DAY

Summary of the Neural Mechanism Necessary to Postural Reaction:

1. Receptor. The static labyrinth including the semicircular canals, the utricle and saccule. Adequate stimulus: The position of the head so that the ventral surface of the labyrinth is not nearest to the surface of the earth.

2. Afferent peripheral nerve fibers. The vestibular division of the eighth nerve.

3. The brain-stem receiving nucleus. The nucleus of Deiters, the triangular nucleus of Schwalbe and the nucleus of Bechterew (vestibular nuclei).

4. Transegmental connecting fibers. Myelinized collaterals extending between the several vestibular nuclei.

5. Conversion centers. The nuclei of Deiters, Schwalbe and Bechterew.

6. Intersegmental efferent conduction fibers. The ipsilateral and contralateral Deiterospinal fibers, descending in the spinal cord.

7. Neuromuscular effector fibers, the spinal accessory nerve and all of the motor nerves of the spinal cord innervating the axial musculature.

Summary of the Neural Mechanism Necessary to Crawling-Approach Reaction:

1. Receptors. The vagal sensory nerve-endings in the fauces, trachea, bronchial tree and lungs; also the vagal sensory endings in the stomach and small intestine; sensory end-organs of the trigeminal nerve in face, lips and mouth; cochlear end-organs.

2. Brain-stem receiving nucleus. The dorsal nucleus of the vagus nerve in the medulla oblongata; substantia gelatinosa; superior olive and trapezoid nucleus.

3. Intersegmental connecting fibers. The myelinized fibers arising in the dorsal vagal nucleus ascending in the posterior longitudinal fasciculus to the reticular formation of the midbrain, that is, the vagomesencephalic portion of the posterior longitudinal fasciculus; lateral fillet to inferior colliculus (Figs. 26 and 27).

4. Conversion and correlating centers. The reticular formation of the midbrain and inferior colliculus.

5. Intersegmental efferent conduction fibers. The mesencephalic reticulospinal fibers which enter into and form the major portion of the predorsal bundle. This bundle constitutes part of the ground bundle of the spinal cord and passes through the medulla oblongata in close relation with the posterior longitudinal fasciculus.

Fig. 32.—Section through the midbrain of the kitten at birth, showing the manner in which the mesencephalic reticulospinal fibers approach and enter the dorsal decussation of Meynert.

Fig. 33.—Section through the reticular formation of the midbrain in the six-day old kitten at the level of the oculomotor nucleus. The myelinized fibers in the extreme lateral position are those of the mesial fillet and collaterals from the spinothalamic tract. Other myelinized axons are oculomotor nerve fibers, colliculospinal fibers and the ascending mesencephalic root of the trigeminal nerve.

6. Neuromuscular effector fibers. The motor elements in the spinal accessory nerve and the cervical, brachial, lumbar and lumbosacral plexuses, to a less degree the motor fibers of the thoracic nerve.

Summary of the Neural Mechanism Necessary to Sucking Reaction:

1. Receptors. The sensory end-organs of the trigeminal region about the nose and lips.

2. Afferent peripheral fibers. Fibers of the trigeminal nerve.

3. Brain-stem receiving nucleus. The substantia gelatinosa of Rolando.

4. The transsegmental connecting fibers. Myelinized nerve fibers from the substantia gelatinosa of Rolando to the nucleus of the hypoglossal nerve, vagus nerve, pharyngeal nerve, facial nerve and the nucleus masticatorius.

5. Conversion and correlating centers. The several nuclei above enumerated cooperating to produce closure of the mouth necessary to sucking and deglutition; the reticular formation in the midbrain.

6. Intersegmental efferent conduction fibers. The mesencephalic reticulospinal fibers in the predorsal bundle.

7. Neuromuscular effector fibers, the afferent fibers of the motor division of the fifth nerve, motor fibers of the seventh, ninth and twelfth nerves, also nerves to extremities and trunk.

ANALYSIS OF THE SYNERGIZING REACTION

During the next six days the kitten develops no new purposive acts and subsists by means of the adaptations which it makes immediately after birth. All of the movements of these several unlearned reactions, particularly those of the head and body, at first show a notable unsteadiness which in the clinical sense is a pronounced ataxia. This incoordination of movement, while it does not render impossible the performance of the several reactions, is not without its embarrassments to them. Why, moreover, it should persist for so long a time postnatally, is difficult to understand. In any event, the unsteadiness of the head and axial movements generally is a prominent feature of the behavior of the kitten until the seventh day. Then there is a striking introduction of coordinative control in the movements of the head and body. This control partakes in its nature of a definite synergizing of the muscle groups which heretofore performed their function without this quality in their action. To speak of this synergizing influence which becomes apparent on the seventh day as a distinct and separable component of behavior, may be open to criticism. There are grounds to regard it not so much as a behavioral component as a quality necessary to all somatic motion. As a quality of somatic motor control, it depends on the proper action of the synergic units of the axial musculature. The extensors and flexors of the head, as well as the rotators in the neck, cooperate in their action. The muscles may be conceived of as arranged in synergic units, each unit consisting of an anatomic agonist and antagonist. It has been believed that when a motion such as flexion

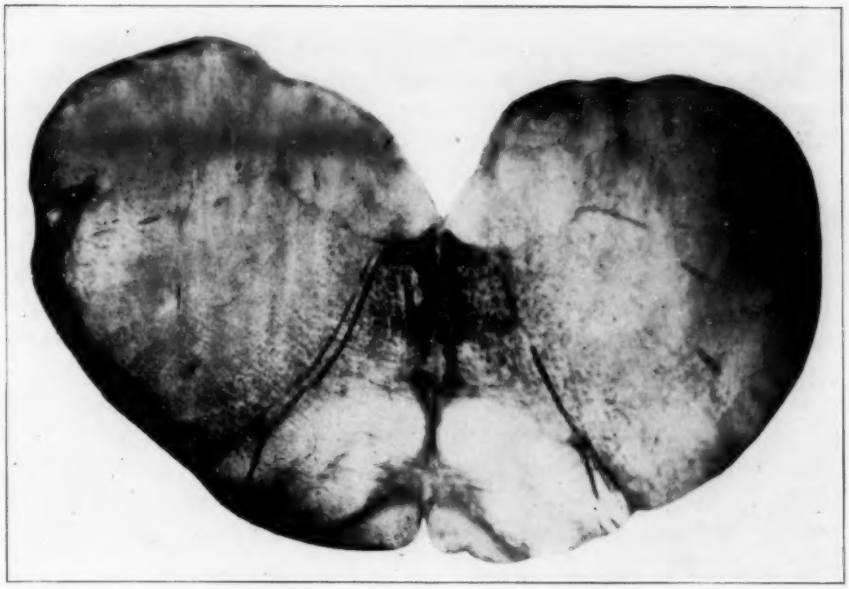

Fig. 34.—Cross section through the oblongata in a six-day old kitten, showing myelinization in the juxtaraphéal, descending trigeminal, Deitero-spinal fibers and cerebellar tracts.

Fig. 35.—Section through the midbrain of a six-day old kitten, showing myelinized optico-oculomotor fibers leaving the optic tract and finally reaching the cephalic extremity of the oculomotor nucleus.

of the head is produced, the flexors undergo contraction while the corresponding extensors pass through a phase of reciprocal relaxation. Recent work bearing on the relation of the muscles in the synergic unit indicates that both sets of muscles, that is, the flexors and extensors, actually contract, and the flexor in this case being predominant, produces the motion, while a certain check element is provided by the extensor to control the range of motion.

The swaying, unsteady and ataxic movements of the head and trunk noted in the kitten during the first six days of life are regarded as dependent on the as yet imperfect control of the synergic units of coordination. This imperfection is due to the fact that the chief organ of coordination, the cerebellum, is not connected with the proprioceptors of the body nor with the effectors. In fact, this connection is not completed until the sixth day, at which time the swaying movements of head and trunk acquire steadiness and precision. This acquisition of synergy in the axial muscles has led to the recognition of an important behavioral component, the synergizing reaction.

ANALYSIS OF THE PRIMITIVE ESCAPE REACTION

In addition to the reaction which produces synergic control in the axial muscles, another response appears on the seventh day. This manifests itself in a new and more highly systematized reaction by means of which the animal escapes from painful or hurtful stimuli. In the early days of life and during the first week, the young kitten utilizes a seemingly diffuse mechanism in the attempt to escape from painful stimulation. If the kitten on the second or third day is touched with the point of a pin while resting on a supporting surface, it immediately gives a sharp cry, makes a sudden contraction of all its limb and trunk muscles so that it lurches over on its back, where it lies sprawling until it struggles over into the physiologic posture again. This reaction is both diffuse and inefficient. If continued into adult life without extensive modification, it would permit the animal to fall an easy victim to such natural enemies as might suddenly apply hurtful stimuli to it. In biologic terms, this response, while it does produce escape from injurious stimuli, at the same time throws the kitten off balance, puts it out of proper position, leaves its defense wide open and prepares no element of counter attack. Evidently there is neither proper provision for regulating the relative intensity of stimuli nor any mechanism for integrating these stimuli to form an effective incentive to react. Totally different is the response to pin-point stimulation in the eight-day old kitten. Now, if lying quiet with the eyes closed and touched with the point of a pin, the animal opens the eyes at once and moves the body so that the head is directed toward the source of the stimulation. It is not thrown off balance nor put out of proper position. This reaction

has gained the further advantage of directing the eyes toward the source of trouble, while the entire attitude is well calculated for counter-offensive.

The introduction of this reaction has been regarded as an actual behavioral component. In all probability, it serves as the substratum on which, in later periods of development, more complex escaping and avoiding reactions are constructed. It was in fact the development of still more complicated and later escaping reactions which led us to look on this behavioral component as the primitive escaping reaction.

Fig. 36.—Section through the optic chiasm of a six-day old kitten, showing a slight degree of myelinization in the optic fibers.

It provides a more effective reaction by which the animal may escape unfavorable pressure in the event that it is accidentally stepped on by the mother, or the sharp claws of the other kittens scratch its skin. It differs from the early reflex avoidance movements in the fact that the constituent muscular acts are continued until the purpose is finally achieved.

ANALYSIS OF THE EYE-OPENING REACTION

Another component of behavior makes its appearance on the seventh day, the eye-opening reaction, as the result of which both upper eyelids are retracted and light for the first time has access to the retina without the necessity of passing through the palpebral tissues. This reaction plays such a prominent rôle in the future development of the kitten

that it seems fair to regard it as a distinct behavioral component. After the eyes are open, a new sense is made available for the further organization of behavioral responses. Visual function as such does not, however, come into play at this time. Repeated experiments showed that the kitten makes little or no actual use of the sense of sight for some time after the eyes open. The flashing of a bright light in its eyes, the rapid and slow movement of objects drawn across its field of vision, the sudden approach of objects which seem to have the intent of striking, elicited no response dependent on vision. The animal of these tests seems quite as sightless as when its lids are closed. Its groping manner of approach shows no change, it has no winking reflex, although the iris in response to a ray of light thrown on the retina, manifests the typical pupillary reflex.

By the seventh day of extra-uterine life the kitten has acquired three new performances in its motor activities: (1) the synergizing reaction in consequence of which its axial musculature acts with greater steadiness and precision; (2) the primitive escaping reaction by means of which the animal avoids hurtful stimuli, and (3) the eye-opening reaction by means of which light is admitted directly to the retina although visual function does not yet seem to be established.

These accessions to the behavior of the animal expand its stream of reactions and make possible many combinations which heretofore did not exist. For example, after the eye-opening reaction is established, the elevation of the upper lids may be brought about in response to stimuli from several sources. Certain variations in the reaction stream may also be observed at this time indicating the possible degree of somatic response of the animal from a level where such response is essentially negative, as in sleep, to one in which every possible reaction has been brought into play. Some of these responses may now be elicited through several different afferent approaches; as for example, the gastro-intestinal, vestibular, muscular, cutaneous, articular, cochlear and optic receptors. At first, impulses passing inward from these different receiving stations are capable only of the most meager combinations and produce correspondingly simple motor performances. Subsequent development reveals a tendency of the motor performances to accomplish more definite and complex purposes, progressively adjusting the animal in its approach toward the conditions of adult life. The eye-opening reaction, shortly after its appearance, may be elicited by several different types of stimuli. A sudden, sharp noise made in the vicinity of the sleeping kitten will cause it to open its eyes, as will also a bright flash of light. If lying quietly asleep and stimulated with a pin-point, as already shown, the kitten will among other adjustments in response to this stimulation, elevate its eyelids. If allowed to fall asleep when placed on a strip of cloth, and by this means gently rolled out of its

physiologic posture, it immediately opens its eyes even before it begins to readjust itself. When hungry, it now opens its eyes before crawling to the mother, and the eyes usually remain open while searching for the nipple.

Explanation of these added reactions seems possible by means of certain systems of fibers which acquire their myelin sheaths on or about the sixth day. The introduction of these fiber systems into the operating mechanisms of the central nervous system would provide a means for the performance of each one of the new behavioral components. In

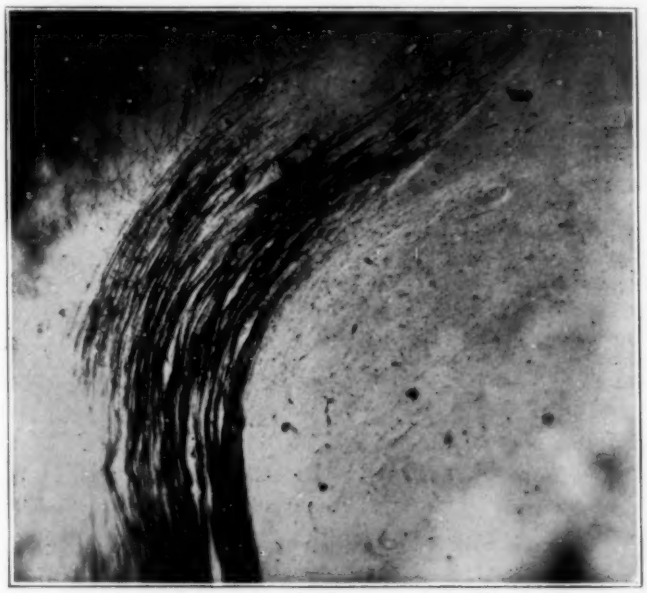

Fig. 37.—Section through the midbrain in a six-day old kitten, showing the optic fibers, although partially myelinized, still unmyelinized as they approach the tectum mesencephali.

the case of synergizing reaction the most striking advance has been made in the myelinization process. An entirely new system of control over somatic motion has developed, and one of the most important divisions of the brain has been provided the means for exerting its regulating influences over bodily motion. The new myelinization involves both the afferent and efferent pathways connected with the cerebellum. That this organ is of primary importance in the coordinative function, the experimental evidence of the past and the rapidly growing experience of the present seem to put beyond dispute.

On or about the sixth day the following afferent pathways to the cerebellum give evidence of myelinization: (1) the dorsal spinocerebellar tracts; (2) the ventral spinocerebellar tracts, and (3) the ipsilateral

fibers from the dorsal nuclei of Goll and Burdach by way of the posterior external arcuate fibers to the inferior cerebellar peduncle.

These fibers enter into and form the inferior cerebellar peduncle which at this time shows a fairly well marked degree of myelinization. It was noted, however, that the staining reaction in the inferior cerebellar peduncle as well as in its constituent tracts does not appear to have the same intensity as the fiber systems first myelinized, such as the posterior longitudinal fasciculus. The fibers of the inferior cerebellar peduncle may be traced into the cerebellum where they proceed to divide into a number of small bundles which end in the vermis. None of these peduncular bundles has any relation to the lateral cerebellar lobes (Fig. 28).

In addition to the myelinized fibers in the inferior cerebellar peduncle, there is considerable myelinization in fibers which extend from the neighborhood of the triangular and Deiteral nucleus to the roof nuclei of the cerebellum. These elements constitute the first representatives of the juxtarestiform body and bring the Deitero-spinal system into relation with the inferior vermis of the cerebellum.

At this period also myelinized fibers may be discerned arising from the dentate nucleus, which is connected with the cerebellar cortex of the folia in the vermis. The fibers arising in the dentate nucleus become convergent as they pass cephalad and soon merge to form a well defined myelinized bundle constituting the superior cerebellar peduncle. The superior cerebellar peduncle may be traced by its myelinization forward along the outer wall of the fourth ventricle, through the isthmus and into the midbrain, where it undergoes decussation by two long sweeping sets of transverse fibers, one in a ventral position and one more dorsally placed. These two sets of transverse fibers converge toward the midline where they cross, forming the decussation of the superior cerebellar peduncle. The decussation may be followed to the red nucleus where at this stage it terminates. There are no myelinized fibers observed in connection with the red nucleus cephalad of this level on the sixth day (Fig. 29).

Emerging from the red nucleus, however, and crossing the midline immediately after their convergence in the ventral commissure of Forel, is a considerable bundle of fibers which are well myelinized and constitute the rubrospinal tract. The course of this tract may be followed in its typical position through the midbrain and bulb into the spinal cord (Fig. 28).

The fibers of the superior cerebellar peduncle, together with those in the rubrospinal tract, form the efferent pathway for impulses arising in the cerebellum. Both afferent and efferent elements in the cerebellar or coordinative reflex path are present and capable of conduction because of their myelinized condition at this stage. In this light, a mechanism

providing for synergic control has been introduced and explains why the swaying, ataxic and uncertain movements of the head and trunk have been replaced by more precise and direct motor performances. This coordinating function limits itself, however, to the axial musculature. The movements of the limbs are still ataxic and uncertain. This fact, we believe, indicates that the parts of the cerebellum which are primarily concerned with the synergic control of the appendicular structures, namely, the lateral lobes, have as yet received no afferent myelinized connections, nor have they established efferent communication. The introduction of synergia in the control of limb movement comes at a considerably later period.

The interpretation given the primitive escaping reaction depends on the myelinization on or about the sixth day of two groups of somatic sensory fibers, namely:

1. Fibers from the dorsal nuclei of Goll and Burdach passing transversely across the medulla as the internal arcuate fibers, crossing the midline to form the decussation of the mesial fillet and turning cephalad as the mesial fillet. These fibers are only faintly myelinized.

2. A bundle which in the oblongata is situated lateral to the mesial fillet but which subsequently comes into closer relation to it, the spinothalamic tract.

Both of these bundles may be traced as far cephalad as the superior collicular region of the midbrain. Beyond this point there is no myelinization in either bundle. On reaching the level of the superior colliculus, the fibers which have ascended as the mesial fillet and spinothalamic tract, pass in long sweeping arcs dorsally and mesially and end in the mesencephalic tegmentum. Their endings appear to come into close relation with the origin of the mesencephalic reticulospinal fibers. If the reticular region of the midbrain is an area for the correlation of sensory stimuli capable of inaugurating complex associated movements, it seems probable for the afferent impulses borne to this level of the brain from the cutaneous and muscular receptors to activate the movements of a primitive escaping reaction. The animal is thus provided with a reflex arc through the mesencephalon which acts in the conduction of impulses necessary to the purposive automatic associated movement employed by the kitten in avoiding hurtful stimuli (Fig. 33).

The explanation of the eye-opening reaction was seen in the myelinization of fibers in the optic tracts. On or about the sixth day, many of the fibers constituting the optic commissure and tract appear fairly well myelinized. Some of them, and particularly those in the mesial part of the optic bundles, are more heavily invested with myelin than the more laterally placed fibers. The optic fibers may be followed dorsally until they come in relation with the superior colliculus. They divide into two

bundles, a stratum superficiale and a stratum profundum, which curve inward toward the midline and may be traced a short distance only because of the lack of myelin in this part of their course. The myelinization of these fibers is not complete and no myelinized fibers from this source reach the tectum of the mesencephalon. There is no evidence at this stage of optic fibers connected with the pulvinar of the optic thalamus, and only a few fibers with myelin sheaths have come into relation with the lateral geniculate body. From the mesial and more heavily myelinized division of the optic tract, numerous fibers are observed to bend sharply inward and may be traced mesially as far as the cephalic extremity of the oculomotor nucleus. Such optico-oculomotor fibers were predicated by Bechterew [3] on the basis of some of his earlier experiments. These experiments seem to indicate that pupillary fibers after they have left the optic tract a short distance behind the optic chiasm reach the nuclei of the oculomotor nerve. Such myelinized fibers would complete a connection between the retina and the nuclei of the oculomotor nucleus making possible the elevating of the upper lid and the regulating of the size of the pupil in response to light. That these are not visual or sight fibers seems to be clearly indicated by their destination. Their presence and detection in the young kitten which gives no evidence of visual function seems to justify the assumption of previous observers that light fibers actually do exist in the connection between the retina and the midbrain. That the visual function has not been established in the kitten was demonstrated by many tests, and is morphologically now confirmed by the failure to discern myelinized fibers extending to the optic thalamus, to the tectum mesencephali or into the lateral geniculate body. The myelinized fibers in the optic tract which connect with the oculomotor nucleus are interpreted as light fibers which, as soon as they acquire their myelin sheaths, convey light impulses even through the closed lid to the oculomotor nucleus and thus determine the eye-opening reaction seen on the seventh day (Figs. 35 and 36).

The following myelinized fibers make their appearance on the sixth day of extra-uterine life in the kitten:

1. The ventral spinocerebellar tract.

2. The dorsal spinocerebellar tract.

3. Ipsilateral fibers from the dorsal column nuclei of Goll and Burdach to the inferior cerebellar peduncle.

4. Juxtarestiform fibers.

5. Dentatorubral fibers entering into and forming the major portion of the superior cerebellar peduncle.

6. Rubrospinal fibers arising in the nucleus ruber, decussating in the commissure of Forel and descending through the isthmus, hindbrain and medulla oblongata to the spinal cord.

7. Mesial fillet fibers as far as the midbrain only.
8. Spinothalamic fibers as far as the midbrain only.
9. Optico-oculomotor fibers.

An illustration of a cross section of the oblongata at the level through the middle of the inferior olive in the six-day kitten is shown in Figure 34. The additional myelinized fibers in the mesial fillet, cerebellar, rubrospinal and spinothalamic tracts are clearly demonstrated.

NEURAL MECHANISMS INVOLVED IN THE BEHAVIORAL REACTIONS ON THE SEVENTH DAY

Summary of the Synergizing Reaction:

1. Receptors. End organs in muscles and joints in neck and trunk. Adequate stimulus: movements of body.
2. Afferent peripheral nerve fibers. The cranial and spinal nerves from neck and trunk muscles and joints.
3. Receiving nuclei and ascending tracts. Clarke's column in the cord and cells in dorsal gray column sending ascending axons into the now myelinized spinocerebellar tracts to the vermis of the cerebellum.
4. Connecting fibers from the cortex of the vermis to the cerebellar nuclei.
5. Efferent conduction fibers. The superior cerebellar peduncle and the cerebrospinal tract.
6. Neuromuscular effector fibers. The spinal accessory nerve and all of the motor nerves of the spinal cord innervating the axial musculature.

Summary of the Primitive Escape Reaction:

1. Receptors. End organs in skin, muscles and joints. Adequate stimulus: hurtful cutaneous, muscular or joint factors.
2. Afferent nerve fibers. Sensory divisions of the cranial and spinal nerves.
3. Receiving nuclei and ascending tracts. Dorsal horn of spinal cord gray matter (to some extent, probably, the nucleus of Goll and Burdach. Conduction by spinothalamic tract, and mesial fillet to some extent).
4. Conversion center. Reticular formation of midbrain in which myelinized collaterals of spinothalamic tract end.
5. Intersegmental efferent conduction fibers, the mesencephalic reticulospinal fibers in the predorsal bundle.
6. Neuromuscular effector fibers; the motor divisions of spinal and cranial nerves to the neck, trunk and limbs.

Summary of the Eye-Opening Reaction:

1. Receptors. End organs in retina. Adequate stimulus: light at first, later from other somatic and splanchnic receptors.
2. Afferent nerve fibers. Optic nerve and tract just myelinized at this time conveying impulses by the optico-oculomotor fibers to the nucleus of the third nerve, especially to segments controlling levator palpebrae and sphincter iridis.
3. Conversion center. Oculomotor nucleus.
4. Neuromuscular effector fibers. Oculomotor nerve fibers to levator palpebrae and sphincter iridis muscles.

ANALYSIS OF THE HEAD AND EYE TURNING REACTION (OCULOCEPHALOGYRIC REACTION)

Little change is observed in the behavior of the kitten from the seventh day until well toward the end of the second week. On the fourteenth postnatal day, however, a new reaction becomes evident. A striking feature about the kitten prior to the fourteenth day is its apparent lack of visual attention. It makes no attempt to follow objects. On the fourteenth day, or in some instances two or three days later, the animal begins to follow moving objects with its eyes and supplements such ocular movements by turning its head. At first, these movements are limited to the horizontal plane.

A light brought before the kitten's eyes and moved to the right or left will determine movements of the head and eyes in the direction of the moving object. The first responses seem to be elicited by light, although not limited to this stimulation. Any moving object, such as a small piece of paper, a piece of cloth, and particularly some other member of the litter, causes the reaction. Small objects, such as a piece of paper 1 cm. square, attached to a string and drawn before the animal, will not attract its attention sufficiently to produce the head and eye-turning reaction. A bright light, however, about this size, slowly moved in front of the kitten, will produce typical visual pursuit. The rapidity of moving objects likewise seems to condition the response. Objects moved rapidly in front of the kitten's eyes, regardless of their character, fail to produce any turning of the head and eyes in the direction of the movement. On the other hand, slowly moving objects at first seem sufficient to bring out the oculocephalogyric reaction. Only the horizontal element in this reaction is present during the fourteenth day. On the next day the animal moves its head upward in visual pursuit of an object moving away from it above its head. In both cases, i. e., with objects moving horizontally as well as vertically, the distance from the eye must not exceed 6 inches. The maximum amount of response was uniformly obtained by movements along a circumference about 4 inches away from the animal's eyes.

This addition to behavior facilitates the exploration of the kitten's environment by one of its most important distance receptors and furnishes one of its most valuable guides in action. Without the ability to direct its gaze upward and downward and from side to side, the animal's chances of life would be curtailed and its opportunity for further development greatly limited.

The neural mechanism of the oculocephalogyric reaction depends on the extension of certain myelinized fibers already noted on the sixth day. These fibers come from the retina by way of the optic tracts which at

this time of development have reached to and radiated into the superior colliculus, the lateral geniculate body and the pulvinar of the thalamus. They may now be traced without difficulty into the end-stations just mentioned. Not only are the afferent pathways provided by myelinized fibers so that impulses may reach the tectal area of the midbrain, but fibers from this region (tectum mesencephali) pass downward, forward and inward through the collicular region to join the preexisting mesencephalic colliculospinal fibers. They cross in the commissure of Meynert to the opposite side, at which point they turn downward to become constituents of the predorsal fasciculus. In this bundle the tectospinal fibers pass through the isthmus, hindbrain and medulla into the spinal cord, collateralizing as they pass downward so that axons are supplied to the nucleus oculomotorius, the nucleus trochlearis and the nucleus abducentis. Other collaterals reach and terminate in the nuclear areas giving rise to the spinal accessory nerve as well as to the lower motor neurons of some of the upper cervical segments. The reflex connection thus established provides the neural mechanism for the operation of the head and eye turning reaction. To what extent vision in its ultimate sense enters into this reaction must, of course, remain a matter of speculation. The animal appears to be visually aware to the extent that it reacts to light and the presence of moving objects in its vicinity.

The integration of the oculocephalogyric reaction in the more highly synthetized processes of cortical vision soon becomes apparent in the next stages of the animal's development.

The process of myelinization on the fourteenth day of extrauterine life in the kitten has progressed with rapidity, and many fibers are now myelinized in the central axis as well as in all of the suprasegmental structures which before were quite devoid of such myelin deposition. In certain of the convolutions of the forebrain, there is a feeble reaction of the medullary substance to the myelin stain. Only in two instances, however, may the myelinization be traced up to the cortical layer. These two exceptions are the cortex in the gyrus sigmoideus and the more ventral portion of the gyrus ectosylvius. In the case of the following gyri faint myelinization may be observed in the medullary rays, but in no instance does the myelin stain show the presence of fibers in the proximity of the cortex itself. In fact, there is a considerable distance of separation between the ends of the medullated portions of these rays and the cortical stratification.

The gyri in which this separation between cortex and end of medullary ray occurs are the following: gyrus fornicatus, gyrus splenialis, gyrus postsplenialis, gyrus suprasplenialis and infrasplenialis, gyrus lateralis in its anterior, medial and posterior portions, the gyrus supra-

Sylvius, the gyrus Sylvius, the lobus pyriformis, the medial, central and lateral portions of the rhinencephalon.

The medullary rays of the gyrus fornicatus show a considerable degree of myelinizaton, as is also the case with the gyrus Sylvius and the gyrus supra-Sylvius, while in the gyrus lateralis the medullary rays are only feebly myelinized.

There is evidence also at this stage of myelinization in the external and internal capsule as well as in the capsula extrema.

The ansa lenticularis is, however, unmyelinized. Some fibers in the corpus callosum show considerable myelinization.

The optic radiation in the medullary substance of the forebrain presents no myelinization in its retrolenticular portion.

The olfactory tract, the chiasm and optic tract, show heavy myelinization. The alveus and fimbria are slightly myelinized.

In the midbrain, myelinization is well advanced in the stratum zonale mesencephali, the stratum griseum superficiale, the stratum medullaris superficiale, the stratum medullaris intermedia, the stratum medullaris profundum. The mesial fillet, the rubrospinal tract and spinothalamic tract show still further accession to their myelin sheaths, while the pyramidal tracts at this time are quite devoid of any myelinization.

There is a slight degree of myelinization in the lateral cerebellar folia which, however, is very faint, and in no instance do the myelinized bundles extend to the cortex cerebelli.

The posterior commissure of the midbrain is heavily myelinized at this stage and contributes marked increments to the mesial portion of the fasciculus longitudinalis posterior.

SUMMARY OF THE EYE AND HEAD TURNING REACTION IN VISUAL PURSUIT

1. Receptors. Visual end organs in retina. Adequate stimulus: moving objects in near vicinity to eyes.

2. Afferent nerve fibers. Optic nerve and tract to tectum of mesencephalon.

3. Conversion center. Tectum of mesencephalon in which optic fibers now end.

4. Intersegmental conduction fibers. Tectonucleospinal fibers to the nucleus oculomotorius and by way of the predorsal bundle to the nucleus spino-accessorius and such other nuclei in the axis as may send axons to the neck muscles.

5. Neuromuscular effector fibers. Oculomotor nerve fibers and motor fibers to trapezius, sternocleidomastoid and other neck muscles.

CONCLUSIONS

1. The study of behavioral development in the cat makes it possbile to recognize a definite chronologic sequence in the appearance of well-

defined behavioral reactions. The general character of a number of these somatic behavioral components has been investigated and especial attention given to those reactions which develop in the first fourteen days of life.

2. Myelinogeny in connection with these behavioral components affords strong evidence in the cat that the deposition of myelin is coincidental with the establishment of function in definite fiber systems. This coincidence may not, however, be the case in other species, as, for example, the white rat in which both Watson [22] and Donaldson [7] report a complete absence of myelin in the nervous system at birth. We have reason to differ with this opinion and would reserve final judgment in the matter for a subsequent contribution now in process of preparation and based on the further study of the white rat.

3. All of the spinal and cranial nerve roots of the cat are myelinized at birth.

4. The tracts of the central nervous system first to receive their myelin sheaths in the cat are the fasciculus longitudinalis posterior, the fasciculus predorsalis, the Deitero-spinal tracts, the secondary cochlear tracts and the trigeminal tracts (ascending mesencephalic and descending spinal).

5. By assuming a functional capacity as already established in the fibers myelinized at birth, it is possible to explain the first behavioral components manifested by the kitten on the basis of stimuli received and responses determined thereby.

6. Further evidence concerning the coincidence of myelinization and the establishment of functional activity in the nerve fibers is offered by the following striking examples in the six-day kitten:

(*a*) The establishment of the synergizing reaction simultaneous with the myelinization in the spinocerebellar tracts, in the vermis of the cerebellum, in the superior cerebellar peduncle and in the rubrospinal tract.

(*b*) The establishment of the primitive escaping reaction with myelinization in the spinothalamic tract (collaterals to the mesencephalic reticular formation).

(*c*) The establishment of the eye-opening reaction with myelinization in the optic nerves and tracts.

7. The early connections with the reticular formation of the midbrain by means of myelinized fibers and the lack of myelinization cephalad of this level for the first week of life make it probable that this region of the mesencephalon plays an important rôle in the correla-

tions necessary to the primitive automatic associated movements characteristic of the animal's early behavioral reactions.

8. Auditory sense is the only special sense which at birth is provided with a completely myelinized system of fibers. It is probable that this is the only one of the special senses which contributes to the directive influence guiding the early movements of the animal. The most important source of this directive influence, however, is the trigeminal innervation.

9. The scattered distribution of the myelinized fibers at birth makes it appear unlikely that myelinization bears any special relation to the degree of vascularization of the neuraxis as Monakow suggests. Furthermore, the fact that fibers of every size from the smallest to the largest were found among the early myelinized systems in the axis does not lend support to the view of C. and O. Vogt that fiber caliber may in some way influence myelinogenesis.

10. The evidence produced by this study not only seems to support the hypothesis contained in Flechsig's myelinogenetic law, but points to the possibilities of further investigations concerning the structural basis of behavior. It is perhaps premature to draw such far-reaching conclusions as those of Flechsig, especially with regard to the evolution of psychic functions, on the basis of myelinogenesis. Indeed, it would seem wise to defer any deductions of this kind with reference to the higher synthetic processes of the brain until the simpler unlearned reactions are much more fully understood. This will require much research in the behavioral development of many different species, combined with an intensive study of behavior in the infant.

BIBLIOGRAPHY

1. Adami, J. G.: The Myelins and Potential Fluid Cystalline Bodies of the Organism, J. A. M. A. **48**:462 (Feb. 9) 1907.

2. Adami, J. G., and Aschoff, L.: On the Myelins, Myelin Bodies and Potential Fluid Crystals of the Organism, Proc. Roy. Soc., London, Ser. B. **78**:359-368, 1906.

3. Von Bechterew, W.: Die Funktionen der Nervencentra, **2**:1003.

4. Beneke, F. W.: Studien über die Vorkommen d. Verbeitung, u. d. Function von Gallenbestandtheilen, Giessen, 1862.

5. Brodmann, K.: Feinere Anatomie des Grosshirns, in Lewandowsky: Handbuch der Neurologie, Berlin **1**:206, 1910.

6. Déjerine, J.: Sur les fibres de projection et d'association des hemispheres cerebraux, Soc. de biol., 1897.

7. Donaldson, H. H.: American Textbook of Physiology, 1901, Philadelphia, **2**:181.

8. Ellermann, V.: Untersuchungen über Markscheiden Färbungen mit Beitragen zur Chemie der Myelinstoffe, Skand. Arch. f. Physiol. **14**:337, 1903.

9. Flechsig, P.: Die Leitungsbahnen im Gehirn und Rückenmark des Menschen auf Grund entwicklungsgeschichtlicher Untersuchungen, 1876; Zur Anatomie und Entwicklungsgeschichte der Leitungsbahnen im Grosshirn des Menschen, Arch. f. Anat. u. Physiol., Anat. Abt., 1881, p. 12; Gehirn und Seele, Leipzig, 1896; Die Lokalisation der geistigen Vorgänge, Leipzig, 1896; Neue Untersuchungen über die Markbildung in den menschlichen Gehirnlappen, Neurol. Zentralbl., 1898, p. 977; Ueber Projektions- und Associationszentren des menschlichen Gehirns, Le Nevraxe **2**:63, 1901; Entwicklungsgeschilchtliche Flächengliederung der Grosshirnrinde des Menschen, Arch. ital. de biol. **36**, 1901; Weitere Mitteilungen über die myelogenetischen Felder in der menschlichen Grosshirnrinde, Neurol. Zentralbl., 1903, p. 202; Einige Bemerkungen über die Untersuchungsmethoden der Grosshirnrinde, insbesondere des Menschen. (Bericht an die Hirnforschungskommission, Arch. f. Anat., 1905) Ferner Bericht der königl. sächs. Akad. d. Wiss., 1904, pp. 50 and 177; Hirnphysiologie und Willenstheorian, Ostwalds Ann. der Naturphilosophie **4**, 1905; Bemerkungen über die Hörsphäre des menschlichen Gehirns, Neurol. Zentralbl. **1** and **2**, 1908; Anatomie des menschlichen Gehirns und Rückenmarks auf myelogenetischer Grundlage, Leipzig, **1**, 1920.

10. Herrick, C. J.: Introduction to Neurology, Philadelphia, W. B. Saunders Company, Ed. 2, 1918, p. 321.

11. Liebreich, O.: Ueber die Entstehung des Myelinformen, Arch. f. path. Anat. **32**:387, 1865.

12. Mayser, in Koelliker: Handbuch der Gewebelehre des Menschen, Leipzig **2**:439, 1896.

13. Meckel: Versuch einer Entwicklungsgeschichte der Zentralteile des Nervensystems, Deutsch. Arch. f. Physiol. **1**, 1815.

14. Meynert, T.: Vom Gehirn der Säugetiere, in Stricker, Handbuch der Lehre von den Geweben, Leipzig, 1872, Chapter 31.

15. Von Monakow, C.: Demonstration von makro- und mikroskopischen Praeparaten, Neurol. Centralbl. **29**:110, 1910; Ueber den gegenwartigen Stand der Frage nach der Lokalisation im Grosshirn, Ergeb. der Physiol., von Asher u. Spiro, 1902, 1904 and 1907; Ueber die Projektions- und Associationszentren im Grosshirn, Monatschr. f. Psychiat. **8**:405, 1900.

16. Mussen, L. J. H.: An Anatomico-Physiological Study of the Posterior Longitudinal Bundle in Its Relation to Forced Movements, Brain **36**:352, 1913-1914.

17. Paton, Stewart: Human Behavior in Relation to the Study of Educational, Social and Ethical Problems, New York, Charles Scribner's Sons, 1921.

18. Small, W. S.: Notes on the Psychic Development of the Young White Rat, Amer. J. Psychol. **11**:80, 1899-1890.

19. Virchow: Virchow's Arch. f. path. Anat. **6**:562, 1854.

20. Vogt, C., and O.: Neurobiologische Arbeiten. I. Zur Erforschung der Hirnfaserlehre, Jena, 1902. II. Die Markreifung des Kindergehirns während der ersten vier Lebensmonate und ihre methodologische Bedeutung, Jena, 1904. Vogt, O.: Quelques considerations genereales sur la myelo-architecture du lobe frontal, Rev. Neurol. **20**:405, 1910; Die myelo-architektomischen Rindenfelder des Menschen, Neurol. Centralbl. **27**:137, 1908.

21. Vulpius, O.: Ueber die Entwicklung der Tangentialfasern in der menschlichen Grosshirnrinde während verschiedener Altersperioden, Arch. f. Psychiat. **23**:775, 1892.

22. Watson, J. B.: Animal Education, Chicago Univ. Contrib. to Philosophy, 1903, No. 4; Behavior—An Introduction to Comparative Psychology, 1914.

23. Wlassak, R.: Die Herkunft des Myelins; im Beitrag zur Physiologie des nervosin Stutzgeweber **6**:453, 1898.

DISCUSSION

DR. RAMSAY HUNT, New York: I should like to ask the authors whether myelinization studies within such very short periods of time could be taken as a certain index of function; whether within a period of only two, three or four weeks, there might not have been some function of nerve cells and axis cylinders which could have not been determined by the myelinization method. Do they believe that all function of the corpus striatum could be absolutely excluded because evidences of myelinization were not demonstrable by the Flechsig method?

DR. TILNEY: The question concerning myelinization was one of the points which I should have brought out more clearly in my discussion. I think there can be no doubt as to the coincidence in the time of myelinization and the establishment of function. For example, on the second day after birth, the optic nerve and tract are entirely devoid of myelin sheaths; the eyes are then closed. On the sixth day, the optic tract is myelinized up to the superior colliculus, the pulvinar and the lateral geniculate body. On the seventh day, the animal opens its eyes. There seems to be a difference in time of myelinization of perhaps forty-eight hours between the deposition of the myelin sheath and the establishment of function.

Another very interesting bit of evidence as to this coincidence is afforded by the appearance of the rubrospinal tract in its cerebellar division, if I may perhaps make bold in calling it such, for I believe that there is a definite cerebellar division of the rubrospinal tract, which appears at the sixth day coincident with the tract of Flechsig and the ventrocerebellar tract.

On the twenty-first day, when the animal first begins to show connection with the striatum, there must be an abundant stream of impulses down the rubrospinal tract in its striatal division. At this time the animal begins to show its more complicated automatic associated movements. There are many other similar bits of evidence that might be cited in this connection.

TRYPARSAMIDE PENETRATION INTO THE CENTRAL NERVOUS TISSUE WITH AND WITHOUT SPINAL IRRITATION

COMPARISON WITH ARSPHENAMIN *

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FRANK KOLOS
AND
HELEN MARSHALL, M.A.
SAN FRANCISCO

In the treatment of a group of neurosyphilitic patients with tryparsamide, an unusual opportunity was offered for the study of some problems of the arsenic permeability of the meninges. It is true that a considerable literature has been produced showing the arsenic content of the spinal fluid after intravenous injection of arsphenamin, neoarsphenamin, sulpharsphenamin, and other drugs; but the clinical success of tryparsamide in cases of neurosyphilis resistant to these drugs would lead one to believe that the arsenic content of the spinal fluid might differ appreciably under tryparsamide therapy. In addition, the size of the therapeutic dose of tryparsamide and its high arsenic content would make the technical estimation much simpler than in the case of the other drugs.

The material consists of spinal fluid from a total of 109 patients. Of these, ninety-two had received intravenous tryparsamide therapy; fifty-two of these followed meningeal irritation with autoserum. In addition, seventeen were given arsphenamin intravenously, ten following meningeal irritation.

In comparing the relative arsenic penetration subsequent to intravenous injection of arsphenamin and of tryparsamide, paired rabbits were injected, one with 0.15 gm. of arsphenamin per kilogram of weight, the other similarly with an equal amount of tryparsamide. Twenty-three hours later, the animals were killed, and the arsenic content of the blood and brain was calculated by a modification of

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* This research was undertaken with the financial assistance of the Interdepartmental Board of Social Hygiene.

* We are indebted to Dr. Wade H. Brown of the Rockefeller Foundation for our supply of tryparsamide, and for the privilege of publication.

* From the laboratory of the Neuropsychiatric Clinic, Stanford University Medical School.

Sanger and Black's technic of the Gutzeit method of arsenic determination.[1] Briefly, this is as follows:

Ten cubic centimeters of spinal fluid are pipetted into a porcelain casserole, and three times its volume of a mixture of sulphuric and nitric acid added. This is digested over a Bunsen burner to a char, and again nitric acid added until there is no more charring. This is then diluted with water and put into a Gutzeit apparatus with 3 c.c. of sulphuric acid, 10 c.c. of ferric alum solution, and 1 c.c. of stannous chlorid solution, and made up with distilled water to a uniform volume of 50 c.c. A small amount of zinc shot is added, and the rubber stopper inserted. In the stopper of the bottle is fitted a small piece of glass tubing, in which is placed a pledget of glass wool, saturated

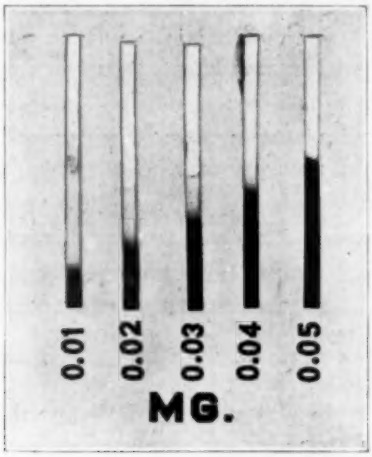

Fig. 1.—Gutzeit arsenic standard.

with 1 per cent. lead acetate solution. Into the end of the tube is fitted a smaller tube, in which is placed a strip of filter paper 4 mm. wide, previously treated with a solution of mercuric chlorid. As soon as the zinc shot is added, an evolution of hydrogen commences, which deposits an arsenical hydrogen on the mercuric chlorid paper. The color of the lowest values is lemon yellow, shading from this through orange to reddish brown in higher values. All reagents and acids used must be arsenic free and tested from time to time for traces of arsenic. A photograph of the Gutzeit arsenic standard is shown in Figure 1.

The results of this experimentation are represented graphically in Figure 2, which is an actual photograph of the mercuric chlorid papers

1. Sanger, C. R., and Black, O. F.: Determination of Arsenic by the Gutzeit Method, J. Soc. Chem. Ind. **26**:21 (Nov. 15) 1907.

stained with arsenic in a typical case. These clearly indicate that arsphenamin tends to remain in the blood, while tryparsamide accumulates in the brain tissue. This neurotrophic character of the drug has already been emphasized by early investigators [2] and also is in harmony with certain clinical findings,[3] namely, that the maximum therapeutic effect of tryparsamide injection is achieved in neurosyphilis, the minimum effect being noted in the treatment of lesions of other tissues.

In our work on human beings, it seemed best to compare the average dose of arsphenamin (0.6 gm.) with the average dose of tryparsamide (3 gm.), rather than equal doses of the two drugs. The amounts of arsenic penetrating the spinal fluid are summarized in Table 1.

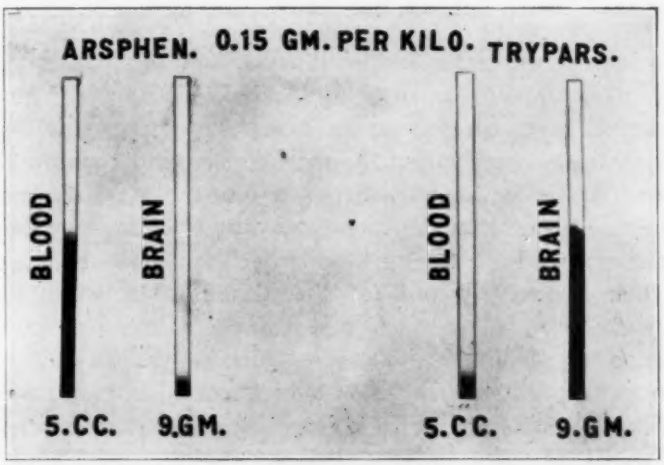

Fig. 2.—Arsenic content of blood and brain substance in rabbits twenty-three hours after injection of arsphenamin and tryparsamide.

Figures 3 and 4 are photographic representations of some average samples obtained by the Gutzeit method. When the meninges were irritated by previous intraspinal injection of autoserum, definitely increased amounts of arsenic were shown in the spinal fluids.

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2. Voegtlin, Carl; Smith, M. I.; Dyer, Helen, and Thompson, J. W.: Penetration of Arsenic Into the Cerebrospinal Fluid, Pub. Health Rep. **38**:19 (May 11) 1923. Pearce, Louise: Treatment of Human Trypanosomiasis, J. Exper. Med. (Supp.) **34**:1 (Dec.) 1921. Brown, W. H., and Pearce, Louise: Tryparsamide, Its Action and Use, J. A. M. A. **82**:1 (Jan. 5) 1924. Lorenz, W. F.; Lowenhart, A. S.; Bleckwenn, W. J., and Hodges, F. L.: The Therapeutic Use of Tryparsamide in Neurosyphilis, J. A. M. A. **80**:497 (May 26) 1923.

3. Moore, J. E.; Robinson, H. N., and Keidel, A.: Tryparsamide in the Treatment of Syphilis, J. A. M. A. **82**:7 (Feb. 16) 1924.

Amount of Arsenic Penetrating Spinal Fluid

Interval Between Intravenous Injection and Lumbar Puncture	Number Cases	Range		Average
		From	To	
Arsphenamin without irritation:				
2 hour	6	"Trace"	0.0025	"Trace"
3 hour	1	.....	.....	"Trace"
Arsphenamin with irritation:				
2 hour	10	"Trace"	0.015	"Trace"
Tryparsamide without irritation:				
1 hour	2	.....	.....	0.01
2 hour	11	0.0075	0.0355	0.0148
3 hour	15	0.005	0.04	0.019
6 hour	9	None	0.03	0.0164
10 hour	1	.....	.....	0.0075
24 hour	1	.....	.....	"Trace"
48 hour	1	.....	.....	0.01
Tryparsamide with irritation:				
2 hour	41	None	0.05	0.0188
3 hour	11	0.005	0.045	0.0236

Mg. of arsenic in 10 c.c. samples of spinal fluid as estimated by the Gutzeit method.

The foregoing results are of interest, first in that they confirm previous work, tending to show the positive neurotrophic qualities of tryparsamide. Second, in human beings, in therapeutic doses, the amount of arsenic penetrating the meninges is vastly greater than that which is found after an intravenous injection of arsphenamin. It is by no means certain that the therapeutic value and arsenic penetration into the spinal fluid are in any way parallel, but it seems reasonable to believe that a drug which is of therapeutic value would have that quality much enhanced if in addition it displayed this marked property of penetration. Third, the increased amounts of arsenic following intravenous tryparsamide injection subsequent to intraspinal injection of autoserum again brings up the much discussed point of the mechanism of spinal irritation. In a previous publication, one of us [4] expressed the opinion that spinal irritation was the essential element in the good therapeutic results achieved by all intradural treatments and that the slightly increased amounts of arsenic found in the spinal fluid after previous meningeal irritation was perhaps only an indicator for other substances—antibodies, etc.—which passed from the blood to the spinal fluid after the barriers were broken down by the irritation. However, the amounts of arsphenamin which penetrate into the spinal fluid at any time, even after irritation, are so small that it was rightly objected by Hall and his associates [5] that the limit of error in the method employed was greater than the difference obtained in our method.

4. Mehrtens, H. G., and McArthur, C. G.: Therapy of Neurosyphilis, Judged by Arsenic Penetration of Meninges, Arch. Neurol. & Psychiat. **2:** 369 (Oct.) 1919.

5. Hall, George W.; Callendar, R. J., and Holmblad, Edward C.: Further Observations on the Presence of Arsenic in the Spinal Fluid, Arch. Neurol. & Psychiat. **3:**6 (June) 1920.

Tryparsamide, however, with its greatly increased therapeutic dose and its greater penetrability, lends itself readily to a solution of this problem. The results we have obtained in these experiments show an appreciable increase of spinal fluid arsenic after previous irritation of the meninges.

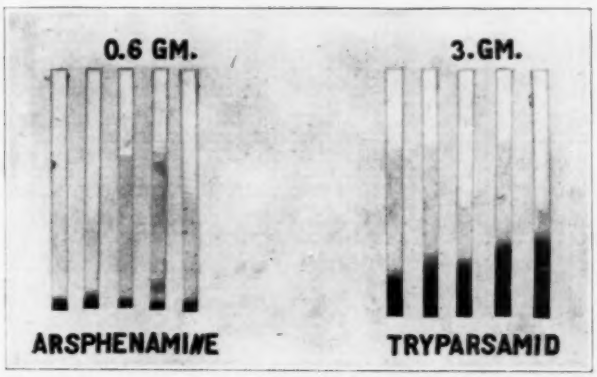

Fig. 3.—Arsenic content of spinal fluid two hours after injection of arsphenamin and tryparsamide with spinal irritation, 10 c.c. samples.

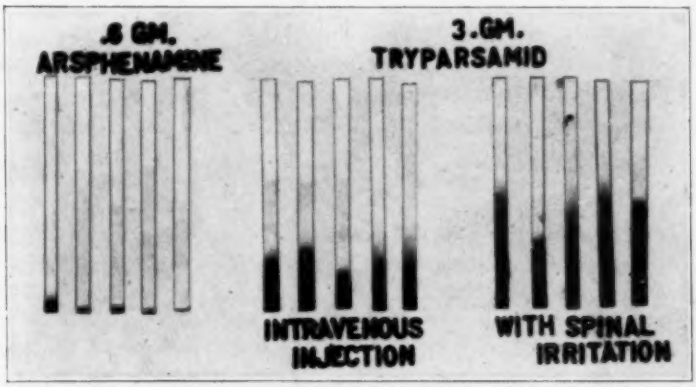

Fig. 4.—Arsenic contents of spinal fluid two hours after injection, 10 c.c. samples.

Even in view of the success of tryparsamide in cases resistant to other methods, it may ultimately seem best in some cases to combine tryparsamide therapy with intraspinal therapy, thus obtaining not only the advantage of the tryparsamide alone, but increasing its penetrability by meningeal irritation, not forgetting the possible effect of other substances, such as the antibodies, which may pass from blood to spinal fluid at the same time as the arsenic.

SUMMARY

1. Tryparsamide was found to be positively chemotrophic for nervous tissue as compared with arsphenamin.

2. The spinal fluids of patients who had received previous injections of tryparsamide showed as much as two or three times as great arsenic concentration as those who had received intravenous injections of arsphenamin.

3. Spinal irritation increased the arsenic concentration from 25 to 30 per cent. over those cases in which only intravenous tryparsamide was given.

4. Clinically it may be advantageous to add meningeal irritation to intravenous tryparsamide injections in neurosyphilitic cases resistant to therapy.

HERPES ZOSTER; CENTRAL NERVOUS SYSTEM LESIONS SIMILAR TO THOSE OF EPIDEMIC (LETHARGIC) ENCEPHALITIS

REPORT OF A CASE *

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This case of herpes zoster is reported because the patient died six weeks after the onset of the attack, and certain microscopic lesions found in the central nervous system are similar in some respects to the type of lesions present in the brain and spinal cord of patients dying from epidemic encephalitis or from poliomyelitis.

REPORT OF CASE

History.—A well preserved woman, aged 72, developed typical and extensive herpes zoster over the right cervical region, extending from the hairline almost to the clavicle. The vesicles did not extend beyond the midline either anteriorly or posteriorly.

During the vesicular stage the disease ran a characteristic slightly febrile course. This lasted for a week or ten days, and the degree of pain was moderate. As the vesicles began to dry up and afterwards, the patient suffered agonizing postherpetic pain, which could not be controlled by drugs, including large doses of morphin. She began to lose weight and strength and soon became bedridden. About a week before she died she became slightly drowsy. Because this case developed shortly after the main epidemic of lethargic encephalitis (and because of the onset of the drowsiness) symptoms of this condition were carefully searched for, but none were found.

Lumbar puncture performed three days before death showed: normal pressure; cell count, 2 lymphocytes per cubic millimeter; albumin, 4 mm. ring (nitric acid contact test); sugar, normal reduction; globulin, negative; Wassermann test, negative. The patient gradually became weaker and died on Feb. 10, 1922, without the development of further symptoms, six weeks after the onset of the herpes zoster.

Necropsy.—This was performed several hours after death, and permission for examination of the spinal cord was denied, so the spinal ganglia could not be investigated. The abdominal and thoracic viscera were normal for the patient's age. A moderate degree of generalized atherosclerosis, including the coronary arteries, was present. The kidneys showed moderate atherosclerotic change. The lungs showed moderate hypostasis of the dependent portions. No other gross changes were present, and microscopic examination of all the viscera confirmed the gross findings.

The brain and upper cervical cord were removed in one piece, and with the exception of a mild edema of the leptomeninges, no gross abnormality was found, and no unusual redness was present. Pieces of the cervical cord, medulla,

* From the Laboratories of Columbia Hospital.

cortex, cerebellum and midbrain region were placed in a sterile bottle and kept in the icebox over night. The remainder of the brain and cord were fixed in a 10 per cent. solution of formaldehyd.

Microscopic Examination.—No important microscopic changes were found except in the central nervous system. A low power lens showed as many as six or seven blood vessels surrounded by a collar of lymphocytes in any cross section of the cervical cord. The pia-arachnoid showed slight diffuse lympho-

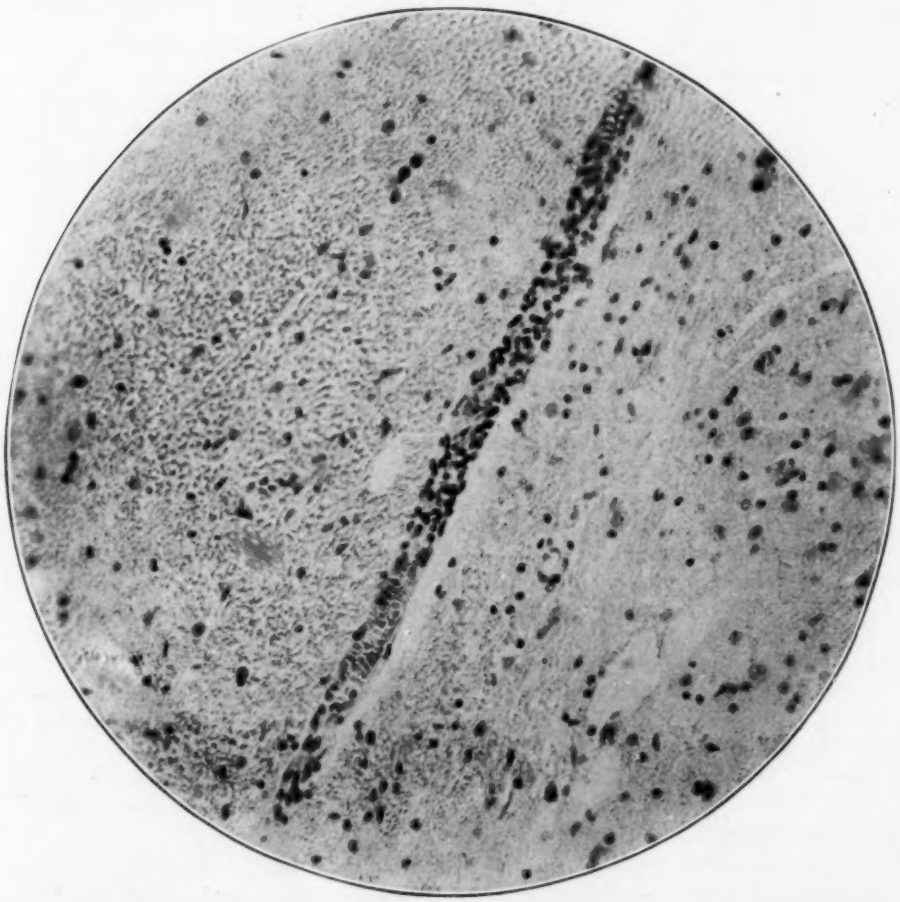

Fig. 1.—Perivascular lymphocytic infiltration of a blood vessel in the cervical spinal cord. Hematoxylin and eosin stain; magnification 250.

cytic infiltration. A moderate number of vessels in the medulla showed the same degree of perivascular lymphocytic infiltration. In the pons fewer vessels were similarly involved. An occasional vessel in the region of the basal ganglia and internal capsule and in the cortex showed a few lymphocytes surrounding it, but none of the vessels in the corpora nigra presented this picture.

In all of the sections there were a larger number of small, round, dark staining nuclei than normal. These were diffusely scattered, were not nuclei of glia cells and apparently were nuclei of lymphocytes. The pia-arachnoid everywhere

showed the appearance of a slight or moderate edema and contained a few scattered lymphocytes.

The day following necropsy the pieces of unfixed material were ground in a mortar with sterile saline, filtered through a Mandler filter (tested to hold back *B. prodigiosis).* The filtrate was used for intracranial injection into four rabbits and for inoculation into six tubes of Smith-Noguchi medium.

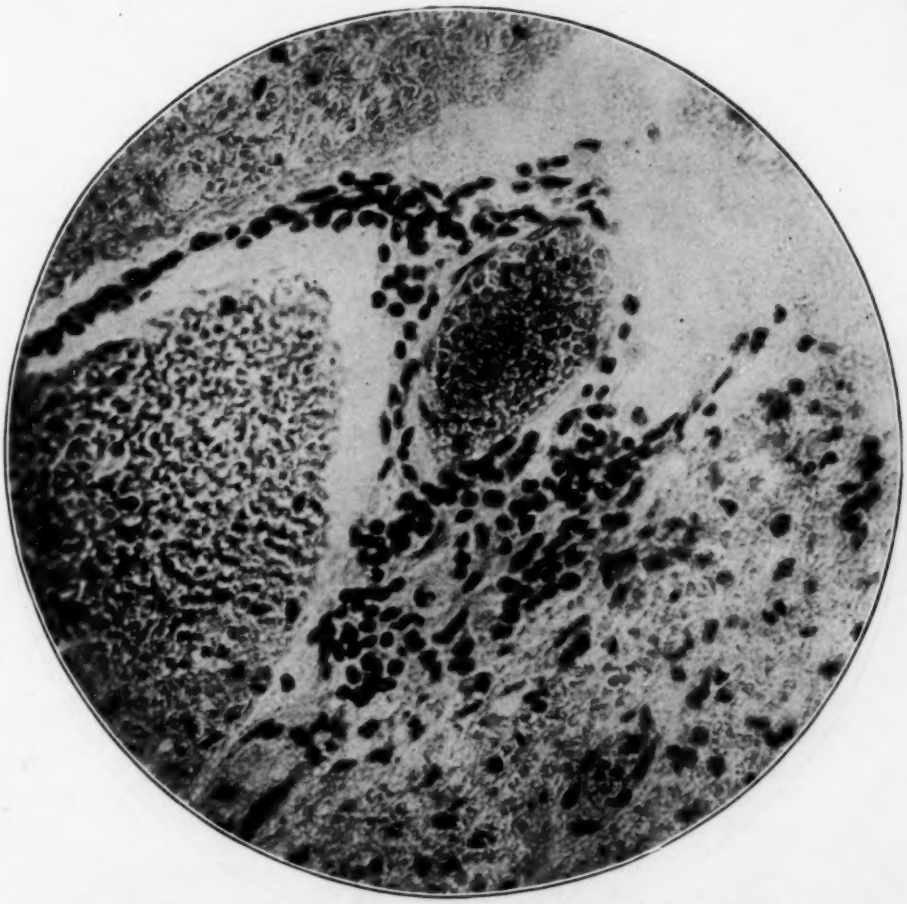

Fig. 2.—Perivascular lymphocytic infiltration of a blood vessel in the cervical spinal cord. Hematoxylin and eosin stain; magnification 600.

The inoculated rabbits remained well and were not killed. In one culture tube a moderate number of minute, round bodies were found with Unna's polychrome methylene blue stain; they had the appearance of extremely minute organisms. Similar bodies were not found in subcultures, and therefore this cannot be considered a proved positive culture. No other organisms appeared in these cultures and control cultures of the original filtrate on the usual mediums remained sterile.

COMMENT

No definite conclusions can be drawn from the findings in this case. It is regretted that it was impossible to examine the spinal ganglia to determine whether the typical lesions described by Head and Campbell were present. There can be no doubt, however, that the patient suffered from herpes zoster.

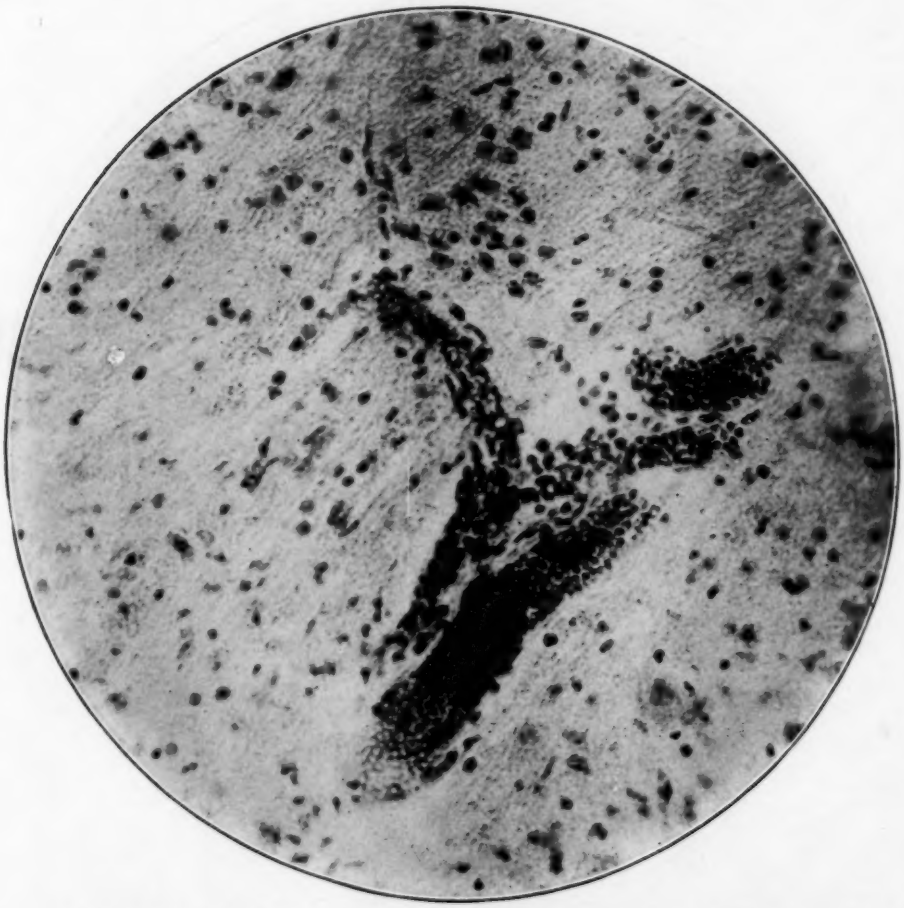

Fig. 3.—Perivascular lymphocytic infiltration of vessels in the medulla. Hematoxylin and eosin stain; magnification 400.

A fairly complete search of the literature has failed to reveal any description of perivascular round cell infiltration in any part of the central nervous system besides the posterior root ganglia, in material from cases of herpes zoster. Therefore this finding seems to be unique, possibly because there has been a lack of opportunity to study suitable

necropsy material. This observation will have to be verified many times before it can have much significance.

The distribution of the lesions in this case is more restricted than that of similar lesions which are caused by epidemic encephalitis and by poliomyelitis, in either of which conditions both brain and cord may be extensively involved. In epidemic encephalitis the lesions are most

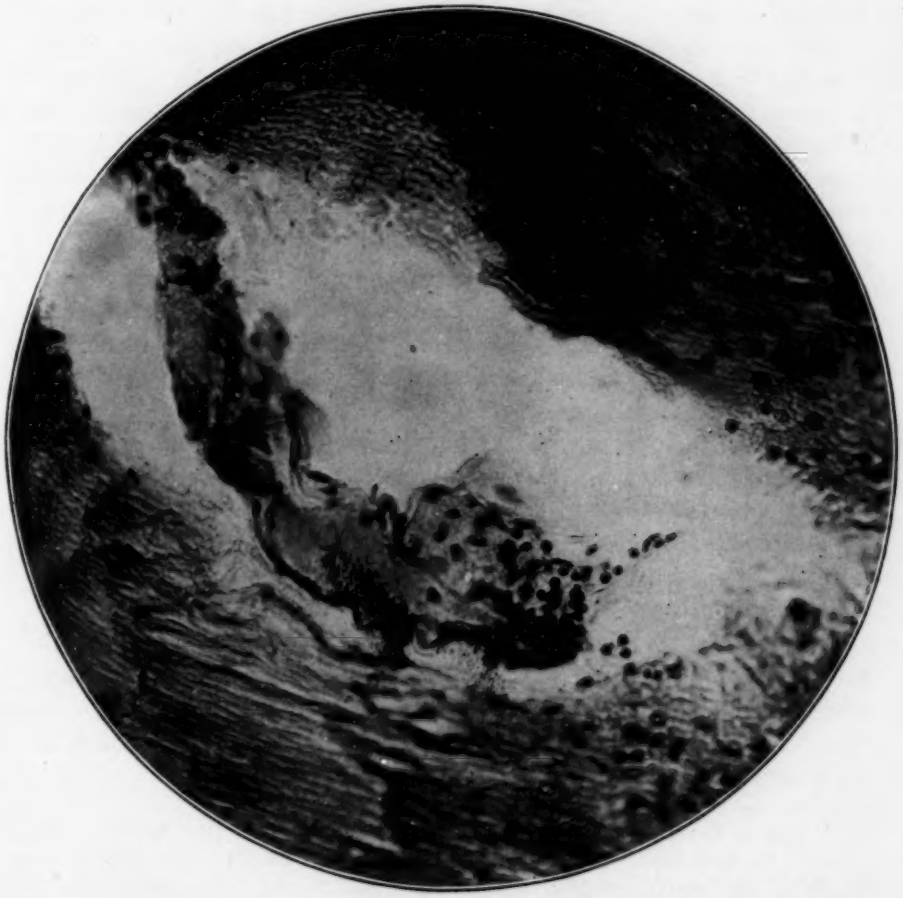

Fig. 4.—Slight perivascular infiltration of vessel in the pons. Hematoxylin and eosin stain; magnification 500.

extensive in the midbrain and are usually especially numerous in the region of the corpora nigra. In poliomyelitis, they are most extensive in the cord and seldom extend above the medulla except in polioencephalitis. In this patient with herpes zoster the lesions were most numerous in the cervical cord but were not confined to the anterior horns, were present in the pons, and as far up as the internal capsule. and were not present in the corpora nigra.

Recent experimental studies of the "virus" of epidemic encephalitis and of the various types of febrile herpes suggests the possible relationship of the causative agents of herpes zoster and epidemic encephalitis. Various investigations have yielded somewhat discrepant results, but certain facts seem established. Epidemic encephalitis seems to be an infectious, communicable disease,[1] and this is true also of febrile herpes.[2]

Under similar experimental conditions, both infectious agents produce symptoms of encephalitis in animals. There is considerable experimental evidence to indicate that both viruses produce similar encephalitic lesions. This evidence has been questioned because of the presence of endemic spontaneous encephalitis in a considerable percentage of rabbits, these animals being most extensively used in the experiments. Further investigations will have to settle this point. The proof of the communicability of epidemic encephalitis is not dependent entirely on the demonstration of encephalitic lesions in rabbits.

The significance is not clear of the intranuclear and extranuclear structures described by Lipschütz, Da Fano, and others, in the skin and brain lesions of herpes and of epidemic encephalitis. On the evidence presented by various investigators, it cannot be decided whether these structures are artefacts or whether they bear an intimate relationship to the infectious agents of these diseases. Because of this confusion at present, these structures were not searched for in the material from the case reported above.

Many observations show that the virus of epidemic encephalitis is filtrable. The virus of herpes has been reported as either filtrable with great difficulty or not filtrable. Some observers have noted experimental cross immunity reactions caused by these two viruses. Other investigators have found that these reactions did not occur. Because of these results the findings in this case of herpes zoster are of interest, even though this disease is clinically as different from epidemic encephalitis as is herpes febrilis.

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1. Loewe, L.; Hirshfield, S., and Strauss, I.: J. Infect. Dis. **25**:378, 1919. Levaditi, C., and Harvier, P.: Ann. de l'Inst. Pasteur **34**:911, 1920. Kling, C., et al.: Compt. rend. Soc. biol. **83**:354, 1920; **84**:521, 815, 1921; **85**:823, 1921; **87**:75, 1922. Thalhimer, W.: Epidemic (Lethargic) Encephalitis, Arch. Neurol. & Psychiat. **5**:113 (Feb.) 1921; Epidemic (Lethargic) Encephalitis, ibid. **8**:286 (Sept.) 1922.

2. Loewenstein, A.: München. med. Wchnschr. **66**:769, 1919; Klin. monatsbl. f. Augenheilk. **64**:15, 1920; ibid. **65**:398, 1920. Doerr, R., and Vochting, K.: Rev. gen. d'ophthal. **34**:281, 409, 1920. Doerr, R., and Schnabel, A.: Schweiz. med. Wchnschr. **51**:496 and 562, 1921; ibid. **52**:325, 1922; Ztschr. f. d. ges. Hyg. u. Infectionskr., **94**:29, 1921. Levaditi, C.: Ectodermoses Neurotropes, Poliomyelite, Encephalite, Herpes, Masson et Cie, 1922. Fano, C. Da: J. Path. & Bacteriol. **26**:85, 1923. Teague, Oscar, and Goodpasture, Ernest W.: J. Med. Res. **26**:85, 1923. Lipschütz, B.: Arch. f. Dermat. u. Syph. **136**:428, 1921.

It would defeat the purpose of this case report to review more extensively the recent experimental studies of febrile herpes and epidemic encephalitis, or to try to arrive at a critical estimation of their significance. Several excellent critical reviews of this literature are readily available.

The possibilities suggested by the case reported are:

1. That herpes zoster in this patient was caused by an infectious agent which is similar to that which causes epidemic encephalitis, and possibly similar to the "virus" which causes febrile herpes.

2. That this patient suffered from epidemic encephalitis, and that the herpes zoster was a secondary effect of this infectious agent.

Herpes zoster and herpes febrilis must be a rare complication of epidemic encephalitis, otherwise their association would be noted in the literature.

The evidence indicates that this patient did not have any of the characteristic symptoms of epidemic encephalitis. The significance of the possible *relationship* of the infectious agents of herpes zoster and of epidemic encephalitis would be just as important if one concluded that either the first or second possibility advanced is correct. Of course the possibility must be mentioned, in passing, that the patient might have acquired both herpes zoster and epidemic encephalitis.

This case emphasizes the importance of further investigation of the possible relationship of epidemic (lethargic) encephalitis, herpes febrilis and herpes zoster.

NONSPECIFIC STIMULATION THERAPY IN TABES DORSALIS

EDWARD H. AHLSWEDE

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The treatment of tabes dorsalis and progressive paralysis through artificial malaria infection is based on the principle of a general nonspecific stimulation of the system to an increased defensive activity. While experiments along these lines have not been completed, it can already be said that a combination of specific and nonspecific measures will direct the future therapy in tabes dorsalis and progressive paralysis. It also seems proved that bismuth is the agent indicated for a combination in this sense. Combinations with arsphenamin have been endorsed by many authors. However, we do not advise these as a general measure for the following reasons: While it is certain that arsphenamin can also act as a nonspecific stimulant owing to its high content of arsenic, it cannot be denied that the toxic dose lies too near the therapeutic dose. In secondary stages in which conditions are entirely different a combination of nonspecific stimulation with specific arsphenamin medication is indicated.[1] In this connection, attention must be called to the recent observations of Weygandt and the clinical results obtained by him in oral nonspecific stimulation therapy. Weygandt and Fischer prepared from the cerebral substance of animals in combination with vitamins, a product which they administered orally in the sense of a nonspecific stimulant, and they obtained decided benefit in the treatment of degenerative disturbances of the central nervous system. These experiments were similar in principle to those which had been made previously by Funck in the treatment of arteriosclerosis, by oral medication of extracts gained from the intima and media of the vessels of young animals. Fischer,[2] working along the same lines, prepared a product which chiefly consisted of nucleoproteins and albuminous substances which were broken down to their amino acids and polypeptids. In the administration of these substances for nonspecific therapeutic purposes, Fischer lays stress on a strong fever reaction which should be provoked and therefore speaks of a "phlogetic therapy."[3] All of these methods are really but a different form of "nonspecific protein therapy,"

1. Fischer: Ueber die unspezifische Therapie und Prophylaxe der progressiven Paralyse **18**:402 (March 26) 1922.

2. Fischer: Bemerkungen zur phlogetischen Therapie und über ein neues Mittel für die Therapie der Metalues, Med. Klin., 1922, No. 19.

3. Markusewitcz: Klinische Erfahrugen mit dem Phlogetan bei Tabes, Parkinsonismus und multipler Sklerose, Wien. klin. Wchnschr., 1923, No. 6.

as they represent only a higher degree of reaction of the latter and not a different underlying principle.

In the artificial infection with malaria the guiding therapeutic idea was to provoke, artificially, within the system a condition which corresponded to that in infectious diseases. For this reason a disease was chosen which is known to cause a rapid temporary rise in temperature. The practical value of this method is, however, limited, since only very well equipped, large institutions could handle such cases because of the danger of a malaria epidemic through insufficient protection against mosquitoes, etc. A second reason of equal importance which contraindicated the malaria method was the fact that in advanced cases of tabes the generally cachectic system could not always be expected to bear the brunt of a new infection.

With these considerations in mind, practical experience has shown us that the introduction of foreign bodies (proteins), in the sense of the above mentioned experiments for general nonspecific stimulation purposes,[4] represent a more effective and practical method for attaining the desired maximum stimulation of the defensive forces of the system. It is not essential, in our experience, to cause a rise in body temperature in each case in order to ensure a lasting effect. While a rise in temperature must always be considered as a reliable sign that a strong reaction is taking place, it is not in itself essential nor decisive for the clinical result of a nonspecific stimulation. The latter in fact must be judged in its effect chiefly by the local reactions, that is, in a case of tabes by the clinical symptoms of temporarily increased lancinating pains, pronounced gastric symptoms, increased ataxia, as well as the general constitutional condition of the patient. In all cases, however, it is essential that both the blood picture and the blood plasm reaction be controlled for immediate influence of the nonspecific stimulation on such vital organs as the brain and the cord. As to the blood picture in these cases, it must be borne in mind that injections of serum and albuminous substances in general as well as all parenteral injections of nonspecific stimulants provoke a distinct decrease (temporary "negative alteration") in the number of the thrombocytes and white cells lasting three or four hours or longer after the injection was made. This might lead to the erroneous assumption that the production of thrombocytes and white cells had been reduced by the nonspecific stimulant, which is not the case, as neither are destroyed or actually reduced and may generally be found accumulated in the liver capillaries. It follows that for practical purposes, the blood picture should not be examined earlier than

4. Ahlswede, H. E.: Nonspecific Protein Therapy, Arch. Dermat. & Syph. **5**:586-588 (May) 1922. Nonspecific Therapy in Syphilis, ibid. **8**:856 (Dec.) 1923.

from ten to twelve hours after the introduction of the nonspecific agent. At this stage, small stimulating doses, following the "negative alteration" of the blood, will provoke an increase in the number of the white cells and platelets, also a pronounced increase of the red cells and hemoglobin content. The control of the sinking velocity of the red cells is, furthermore, of practical importance at this stage, as it furnishes a quick and practical method for judging whether a stimulation has reached its maximum or whether additional stimulations are required in a particular case.

As soon as the nonspecific stimulation has taken effect and a definite clinical reaction has occurred, it is in most cases advisable to begin with specific measures. We do not on principle advise specific medication previous to a nonspecific stimulation as a certain tiring is inevitable, which again would prevent the system from responding fully to a subsequent stimulation. Nor would we at this stage of syphilis advise a rapid sequence of energetic arsphenamin and mercury injections, which always do more harm than good through the paralyzing effect on the activity of the cell protoplasm. This refers only to these stages and not to primary and secondary syphilis.

The specific agent of choice in these stages is bismuth and particularly an oxibenzoic acid compound which in our hands is effective and has not caused disturbances. Bismuth compounds combine a specific effect with a pronounced nonspecific influence. It is advisable to combine them with an organic iodin compound (diiodyl) in preference to inorganic compounds which do not possess the additional nonspecific stimulating qualities which we have observed in the former. The effect and intensity of the specific measures will likewise have to be controlled by the blood picture and the reaction of the blood plasm. While no hard and fast rules can be laid down, the future therapy of tabes will depend essentially on a careful balance between specific and nonspecific measures, while particular stress must be laid on an extreme development of the defensive reactivity of the body cells.

From the aforesaid it follows that for practical purposes small stimulating doses (for example, 2 c.c. of an albumin milk solution) injected into the buttocks, as in mercuric injections, are advisable at the beginning of the treatment. Injections are advisable every three or four days thereafter, provided too strong a reaction does not occur in response to the first. Should the first injection not provoke any reaction or an insufficient one, the dosage of the second injection should be slightly increased. In this way the doses in some nonspecific stimulants have been increased up to 5 c.c. and 10 c.c. (albumin milk) injected intramuscularly. About five injections will as a rule provoke the maximum possible stimulation of the cells. According to our experience, the specific therapy should begin during the last two injections. At the

end of the entire "course," an interval of at least six or eight weeks is necessary to allow the system to recuperate, after which a regular sequence of similar courses is indicated under permanent control of the biologic reaction of the patient.

SUMMARY

The therapy of tabes dorsalis depends essentially on a careful balance between specific and nonspecific measures, while particular stress must be laid on an extreme exploitation of the defensive reactivity of the body in general. Nonspecific protein stimulation is indicated previous to all specific measures. The biologic reaction of the patient (blood picture, sinking velocity of the red cells) requires regular control to ascertain when the maximum stimulation has been attained and to avoid "proteinogenous tiring." For antisyphilitic therapy, bismuth compounds (oxibenzoic acid compound of bismuth) and organic iodin compounds are particularly indicated on account of their additional nonspecific coefficient.

Abstracts from Current Literature

FOCAL INFECTION AND MENTAL DISEASE. NICHOLAS KOPELOFF and GEORGE H. KIRBY, Am. J. Psychiat. **3**:149-197 (Oct.) 1923.

This is the final step in an intensive experiment undertaken about two years ago. The object of the experiment was to determine whether or not focal infection is an etiologic factor of importance in the production of the so-called functional psychoses. Even though it was time consuming and difficult, the experiment was necessary. The theory of focal infection in its causal relationship to mental disease was accepted in certain medical circles, no longer as theory but as accomplished fact; the lay press has written Q.E.D. after the proposition, and the natural inference, namely, extensive and drastic surgery, was being put into more or less general practice. The issue was important. Testimony based on individual cases was of little value in the face of the massive test which was being conducted by the chief exponent of the theory, and which was reported as strikingly successful. Thoughtful psychiatrists realizing that errors are apt to creep in when enthusiasm is unbounded, and that even absolutely honest stastistics may sometimes be misleading, were eager to have a further check and a careful retrial of premises and conclusions.

Kopeloff and Cheney, and later Kopeloff and Kirby, from the Bacteriological and Clinical Departments of the New York State Psychiatric Institute, have concluded an impartial investigation. One hundred and twenty patients divided into "control" and "operative" groups have been conscientiously studied. The aproach was scientific. The physical scrutiny was sharp enough to discern all areas of infection; the laboratory technic followed the methods of well-known experts. In the cases selected for operation the dictum of radical surgical removal was obeyed, with the single exception, that colectomy was not performed, not only on account of the great hazard to life, but also because the administration of *Bacillus acidophilus* milk served to reestablish satisfactory function. Kirby, whose psychiatric judgment is recognized as sound and scientific, took the wise precaution of making and recording a clinical prognosis before treatment was initiated.

The reviewer may merely state the conclusions. In the words of the authors: "On the whole, then, the operated group appears to have improved no more by the elimination of focal infection than the control group which received no operative procedure." It is a tribute to Kirby's psychiatric foresight that not a patient, in whose case an unfavorable prognosis had been given, recovered. The following table is inserted, since it gives in concrete form the actual result of the experiment.

It is necessary to consider briefly the question of the technic, which was employed to demonstrate the foci of infection. Kopeloff and Kirby assert positively that "Focal infections as diagnosed and operated upon at the Trenton State Hospital are not consonant with the procedures employed by other well-established clinics and hospitals." The authors stress the practical impossibility of securing an uncontaminated tooth culture, for even with extreme precaution only fourteen reliable cultures were obtained. Organisms from excised tonsils were frequently similar to those found in the mouths of healthy persons. Apparently, the elimination of the saliva by a dental suction pump results in a remarkable reduction in the number of bacteria to be obtained from the

stomach. Kopeloff and Kirby believe that Cotton diagnoses colon infection on flimsy evidence. Careful technic ("Blood agar plates were streaked with a swab of the cervix taken during the enucleation immediately before the tissue was completely removed. The cervical tissue after excision was cut in half by the surgeon as was the excised racemose glandular tissue and the tissues were shredded with a sterile instrument. Platinum loopfuls from each were streaked on blood agar plates. The other half of these specimens was dropped into 10 per cent. formalin for histological examination.") disclosed the fact that infection of the cervix uteri is not nearly as common as it seemed to be in the Trenton Hospital series. In actual figures, it was 30 per cent. less. The inference is that "either a more reliable technique must be employed or the results (Cotton's) regarded as inconclusive."

One finds it difficult to disagree with either the premises or conclusions expressed in this paper. It is somewhat significant that when it was read before the American Psychiatric Society there was not a single dissenting opinion. It seems fair to state that this experiment has relegated focal infection to its

TABLE 2.—*Results With and Without Operation (120 Cases)*

	D. P.		M-d		Misc.		Total	
	Controls	Oper.	Controls	Oper.	Controls	Oper.	Controls	Oper.
Number of cases..	32	33	25	20	5	5	62	58
Recovered	3%	0%	40%	40%	20%	0%	19%	14%
Improved	22%	15%	33%	35%	20%	40%	28%	24%
Total benefited...	25%	18%	72%	75%	40%	40%	47%	38%
Unimproved	75%	82%	29%	25%	60%	60%	54%	62%

Abbreviations: D. P., dementia praecox; M-d., manic-depressive; Misc., miscellaneous; Oper., operated.

proper rôle in respect to the etiology of mental disease. Nevertheless, every psychiatrist will agree that the final point in the summing up of the authors is sound and embodies good psychiatric practice.

"It is desirable to eliminate focal infection when adequately demonstrated in psychotic patients in the same way as one should attempt to alleviate any physical disorder in mentally diseased patients. Nevertheless, it has not been shown that focal infection is the etiological factor in the functional psychoses."

STRECKER, Philadelphia.

ACUTE BILATERAL RETROBULBAR OPTIC NEURITIS, CURED BY PUNCTURE OF THE THIRD VENTRICLE. J. BASTERRA y G. LAFORA, Arch. de neurobiol. **3**:245, 1922.

A detailed ophthalmologic and neurologic report of a case of acute retrobulbar neuritis, cured by puncture of the third ventricle, is presented in this paper by Basterra and Lafora. The patient, a woman, aged 46, had aborted twice, at two and five months, respectively. Seven years before she came under observation she had undergone an operation for complete hysterectomy. Until two days before she presented herself she had been free from symptoms of her visual disorder—clouded vision in left eye and pain on moving the eye, but several days before this there had been severe headache and pain in the neck, and she had vomited. The patient's husband had had a syphilitic infection twenty-five years before and had taken mercury for two months. At present he shows signs of the pretabetic stage. She had an afternoon temperature of from 37.2 C. to 38.2 C. (99.9 F. to 100.7 F.). She complained also of sudden attacks of pain in the throat and of a sense of constriction on swallowing.

Examination revealed a small grayish yellow tumor between the faucial pillars of the left side which suggested a gumma. There was a positive Wassermann test. Examination of the visual fields revealed: right eye, normal; left eye, concentric narrowing of the field for white; fundi normal. Despite neoarsphenamin treatment, the ocular condition grew worse. Seven days after the first observation light could not be distinguished from darkness with the left eye, and now tortuous veins could be seen in the left fundus and atrophy as shown by pallor on the temporal side. Three weeks later vision in the right eye was greatly impaired so that fingers could be counted only at a distance of 10 cm., and the pupils scarcely reacted to light. On the basis of headache, vomiting, localized percussion tenderness in the frontal region and increasing blindness, tumor of left frontal lobe with acute dilatation of third ventricle was postulated. Because of the rapidly increasing blindness, despite neoarsphenamin treatment, and with the hope of preventing atrophy of the right optic nerve a ventricular puncture under local anesthesia was made. The puncture was made through the corpus callosum after the Anton Bramann technic and from 70 to 80 c.c. of fluid were withdrawn. When the puncture was made, a severe pain was felt in the right eye which persisted for the remainder of the day. The patient also vomited later in the day. Headache persisted for three days, despite the fact that she remained in a recumbent position. The fever, however, disappeared and objects could be recognized at a distance of 10 cm. Six days after puncture she could see objects at a distance of 20 cm., on the seventh day at 1 meter and on the eighth day at a much greater distance, for she was up and could get about the house without stumbling into things. Energetic antisyphilitic treatment was continued and progress continued. Three subsequent lumbar punctures were made for the relief of headache which occurred at intervals and during which vision was affected, all with benefit.

Basterra and Lafora believe this to be the first case reported in which puncture of the third ventricle was performed for the relief of retrobulbar neuritis and was successful. The mechanism of the process, as they conceive it, is an alteration of the secretion of the cerebrospinal fluid resulting from the syphilitic toxin which in turn causes a dilatation of the third ventricle and subdural spaces. They do not maintain that dilatation of the ventricle per se causes neuritis, though recognizing the close relationship of the ventricle with the chiasm. They do not believe that there was compression of the chiasm, for had there been, a hemianopsia of some sort would have been produced. They prefer to believe that the optic nerve bathed in a toxic fluid became inflamed. The constant fever, a condition observed in many cases of neurosyphilis, which did not disappear with antisyphilitic treatment, vanished after ventricular puncture and did not return. This temperature they explain as an irritative phenomenon, cerebral or bulbar, and caused by compression, or, what is more probable, by the toxic cerebrospinal fluid acting on the thermic centers.

FULLER, Boston.

BRAIN ABSCESSES WITH PATHOLOGICAL OBSERVATIONS. CHARLES BAGLEY, Surg. Gynec. & Obst. **38**:1-13 (Jan.) 1924.

The author presents a preliminary report of the study of twenty cases of brain abscesses; seventeen patients were operated on, with a mortality of 47 per cent. Eight of the patients operated on and three not operated on died. Postmortem examinations were obtained in eight of the fatal cases.

The author takes up possible avenues of infection and subdivides this into four groups:

Group 1 contains the extradural type of abscess whose primary source of infection arises from the tympanic cavity and accessory nasal sinuses of the skull. The formation of a brain abscess of this type may occur from (*a*) protrusion of the distended dura into the cranial cavity; (*b*) direct extension from the extradural abscess; (*c*) invasion from the extradural abscess along the blood vessels. Group 2 includes abscesses in which secondary invasion of the brain along the blood vessels without extradural link has been established. He points to abscess of the temporal lobe arising from infection of the superior petrosal sinus which receives veins from both the tympanic cavity and the cortex of the temporal lobe. Likewise certain cerebellar abscesses, he feels, may be an extension of infection from the lateral sinuses.

Group 3 is confined to abscesses caused by a foreign body deep within the brain, in which infection was carried in by the foreign body. Two types of abscess may occur: (1) localized abscess about the foreign body, and (2) abscess about the foreign body with an infected tract which produces a connection between the abscess and the surface.

The fourth group is devoted to superficial abscesses which are open and secondary to direct laceration and infection of brain tissue.

The author takes up the various types of abscess wall and shows that the outcome of the cases greatly depends on this factor. In all inflammatory lesions, the wall formation depends, first, on the type of infecting organism; one of low virulence causing a more gradual accumulation of pus than one of greater virulence with more rapid extension. The resistance of the infected tissue is also important. The two protective types consist of fibrous mesoblastic and glial epiblastic structures; the former is much more effective but is not present in the deeper structures of the brain. He divides abscess walls into four groups: The first consists of dense fibrous mesoblastic tissue walls; the second has a thoroughly formed wall containing some fibers proliferated from the neighboring mesoblastic tissue; the third shows walls of varying thickness, the result of glial proliferation; the fourth has walls showing no evidence of protective reaction.

The paper is well illustrated with many histologic sections and photographic specimens.

The author's summary states that the clinical diagnosis of a brain abscess varies according to the infecting organism, the channel through which this organism reaches the brain and the location of the infection in the brain substance as regards mesoblastic and epiblastic tissues.

TEMPLE FAY, Philadelphia.

AUTOMATIC WRITING AS AN INDICATOR OF THE FUNDAMENTAL FACTORS UNDERLYING THE PERSONALITY. ANITA M. MÜHL, J. Abnorm. Psychol. **17**:162-183 (July-Sept.) 1922.

THE USE OF AUTOMATIC WRITING IN DETERMINING CONFLICTS AND EARLY CHILDHOOD IMPRESSIONS. Ibid. **18**:1-32 (April-June) 1923.

In these studies the author continues the investigation of the phenomenon of automatic writing previously studied by Downey and Anderson, W. A. Melcher ("Dual Personality in Handwriting") and others, a bibliography being appended. Mühl regards automatic writing as a manifestation of the dissociate ideas of the foreconscious and comparable to somnambulism, crystal gazing, the

Ouija board, etc. She schematically represents the mental content as being comprised of six layers; the focus of attention, the conscious, the fringe of awareness, the paraconscious (whence all automatic activity), the personal unconscious and the genetic unconscious. It will be seen that she fuses Freudian and Zurich concepts, "paraconscious," for example, being the equivalent of the Freudian "foreconscious." Curiously, the writer does not mention dreams, which are the best known foreconscious projections, according to Freudian tenets.

In her first study, she presents two patients who were spontaneous producers of automatic writing. The first one was found to have about six personalities manifested by various handwritings and various characteristics. (Not all of them were represented by automatic writing.) The second case was that of a young woman whose chief productions were stories, evidently of a highly fantastical and romantic nature, in which the writer presumes various phases of the personality were expressed.

In her second study, Dr. Mühl presents the results of deliberately attempting to secure sufficient expression of the personality by the writing automatism to break up the existing structure of these dissociated personalities and attempting a resynthesis. She presents first her theory as coordinated with the work of the physiologists and also with that of June Downey on graphology, then describes her technic in detail and then the products of three cases subjected to deliberately initiated automatic writing. In brief, her technic is to suspend the patient's forearm in a sling attached to a string running to the ceiling. The sling is adjusted so that the wrist clears the paper by about an inch, and the slightest impulse therefore has a chance to produce a movement unhindered. The patient is then given something interesting to read aloud, and a pencil is placed in the right hand. Soon the automatic writing begins.

The product is evidently of a sort similar to that produced by free associations, fantasy elaborations and the like. The author believes that automatic writing is simply an expedient means of "getting at unconscious processes quickly" and believes that this is its chief function; "it is an exceedingly dangerous amusement," however, and should be used only by the competent.

MENNINGER, Topeka, Kan.

PARKINSONIAN SYNDROMES OF SYPHILITIC ORIGIN (PURE EXTRAPYRAMIDAL SYNDROME). G. R. LAFORA, Arch. de Neurobiol. **3**:252, 1922.

Lafora reports two cases in which the Parkinsonian syndrome occurred in two young persons with syphilis. The extrapyramidal symptoms were clear cut, the pyramidal tracts in no way involved. Moreover, the symptoms could not be attributed to an epidemic encephalitis, for these patients had not suffered from the disease. The symptoms were regarded as having resulted from syphilitic involvement of the vessels of the corpus striatum.

The patient in Case 1 was an unmarried man, aged 31, who eight years previously had contracted a chancre and had received by way of treatment only one injection of arsphenamin. Until six months before he came under observation he had been free from symptoms, when he began to notice a tremor and weakness of the left arm. Four months later the left leg became involved in the same manner. He had no headache nor any other symptoms that would indicate an epidemic encephalitis. When he presented himself there was neither ankle clonus, a Babinski sign or medullary automatic reflexes. The knee jerks were active and equal. There were hypertonicity and rigidity of the left

extremities, rigidity of the neck, masklike countenance and a parkinsonian tremor of the left hand and foot which was exaggerated on motion. There was also tremor of the head, eyelids and tongue and a tremulous sound to the voice. On walking there was loss of the associative and automatic movements of the left upper extremity. The ocular movements were normal, the pupils stiff to light. There was a positive Wassermann reaction of the spinal fluid; the globulin test was positive; the colloidal gold curve 443300000.

The patient in Case 2 was a married man, aged 37, whose wife had borne him no children and had had no miscarriages. Fifteen years previously he had contracted syphilis and had taken some treatment during the first year. He had never had encephalitis. A year and a half before coming under observation a trembling and rigidity of the right hand began, which interfered with his writing. A little later a similar condition appeared in his left hand. From the beginning there had been increased salivation. At times he had had pain in the right arm, and there had been a period of irritability and asthenia. When the patient presented himself there was rigidity of the upper extremities, neck and face. There was also tremor of both hands with typical pill rolling movements, worse on motion and worse in the right hand. The gait was slow, without spasticity and propulsive, and there was loss of the associative and automatic movements of the upper extremities. He could neither whistle nor grimace, and speech was slow and labored. There were no Romberg sign and no ataxia; the pupils were contracted and almost rigid to light. The knee jerks were normal; there was no evidence of pyramidal tract involvement. The blood Wassermann test was positive; lumbar puncture was refused.

One of these cases, Case 2, did not yield to antisyphilitic treatment. Lafora reviews the literature as it bears on syphilis and the parkinsonian syndrome, pointing out that failure to respond to antisyphilitic treatment does not preclude syphilis as an etiologic factor. On the other hand, there have been instances in which the syndrome has yielded to antisyphilitic treatment in spite of negative biologic tests.

FULLER, Boston.

LATE ULNAR NERVE PALSY. EDWIN M. MILLER, Surg. Gynec. & Obst. **38**:37 (Jan.) 1924.

The author reports a series of cases of fracture of the humerus, showing late ulnar nerve involvement. He classifies the nerve lesions as: primary, occurring at the time of injury; secondary, the appearance of nerve lesions during the weeks of bone repair; and thirdly, those of late paralysis making their appearance many years after the fracture occurs and, in some cases, long after the incident has been forgotten.

He summarizes the causes for this late type of paralysis: In practically all cases a fracture at the elbow in childhood, usually between the third and fifth year; although occasionally the site of injury may be at the internal condyle, or in the supracondylar region. In the vast majority of cases, the line of fracture begins laterally just below the epicondyle and passes obliquely downward into the joint, causing a complete separation of the external condyle (capibellum). The broken capibellum is displaced laterally and forward, and the fractured surface is twisted downward and is not greatly reduced by manipulation. As a result, nonunion of the condyle occurs. The growth of the humerus on its lateral side is thus interfered with to such an extent that a cubitus valgus develops. As the deformity occurs, the olecranon process becomes impinged against the medial condyle. The ulnar groove becomes but a shallow depression

and the nerve itself is displaced from its bed, where it becomes subjected not only to stretching when the arm is flexed and extended, but also to repeated slight trauma, which in time leads to partial or complete ulnar palsy. This paralysis may begin as early as three years, or as late as forty years after the injury, and in 40 per cent. of the cases, it is noticed between the twentieth and thirtieth year after the fracture occurs.

Four methods of treatment are outlined by the author:

(*a*) Correction of the deformity at the elbow by cuneoform osteotomy of the humerus, no operation on the nerve itself being necessary (Mouchet), (*b*) simple liberation of the nerve from its bed, (*c*) liberation of the nerve at the elbow and replacing it in a groove by the removal of a wedge shaped piece of bone and lining it with aponeuroticofascial flap, (*d*) transplantation of the nerve to the flexor side of the elbow. The latter is the method advocated by the author and the one most approved in this country. The results from his cases bear out the relief obtained by this latter method.

In conclusion, he states that fractures of the external condyle of the humerus, which occur most often in childhood, should be operated on if the loose fragment cannot be actually reduced by manipulation, for the growth disturbances following nonunion are likely to result in a marked valgus deformity which may, in later years, produce a paralysis of the ulnar nerve. If this occurs, it is the duty of the surgeon to relieve the tension on the ulnar nerve as soon as the first signs of paralysis appear, either by a correction of the deformity, as recommended by Mouchet, or by transplantation of the nerve to the flexor surface of the elbow.

TEMPLE FAY, Philadelphia.

THE ETIOLOGIC RELATION OF ACHYLIA GASTRICA TO COMBINED SCLEROSIS OF THE SPINAL CORD: THE RELIEF OF SYMPTOMS FOLLOWING ADEQUATE HYDROCHLORIC ACID THERAPY. DOUGLAS VANDERHOOF, Arch. Int. Med. **32**:958 (Dec.) 1923.

In an analysis of 451 patients with achylia gastrica, the author found twenty-nine with definite evidence of combined sclerosis of the spinal cord; of these twenty-nine, fourteen had pernicious anemia. Seven cases form the basis of the present study. Cases complicated by pernicious anemia were not included. With one exception, all showed evidence of focal infection: apical abscesses, pyorrhea alveolaris, prostatitis or infected tonsils. The blood Wassermann reaction was negative in all instances. The achylia gastrica was demonstrated by repeated gastric fractional analyses. The treatment consisted in the removal of foci of infection and in the regular and persistent administration of one teaspoonful of the official dilute hydrochloric acid with each meal. The results of this therapy were gratifying: four patients were subjectively cured or improved; one patient died of progressive spinal cord symptoms; two patients who discontinued the use of hydrochloric acid were unimproved.

The author supports the following theory as to the pathogenesis of combined sclerosis of the cord and pernicious anemia. Both are associated with achylia. In both the achylia precedes the development of cord or anemic symptoms. In both oral sepsis appears to be fairly constantly associated. The absence of hydrochloric acid in the gastric juice removes a potent bacteriolytic factor and allows living bacteria to pass through to the intestines. Moreover, food passes through the achylous stomach unprepared by usual gastric digestion and is open to bacterial decomposition. As a result of such decomposition, the

author regards it as probable that toxins are elaborated. In some instances a neurotoxin predominates, and the spinal cord is attacked; in some instances a hemolytic toxin predominates, and anemia results; in other instances, both toxins are formed, and the clinical picture is one of combined sclerosis of the cord associated with pernicious anemia.

VONDERAHE, Cincinnati.

DREAMS AND TELEPATHY. SIGMUND S. FREUD, Internat. J. Psychoanal. 3:283-305 (Sept.) 1922.

The popular interest in the occult has revived the old theory of telepathic dreams, to which Freud contributes this discussion. He proposes that telepathy and dreams have very little, if anything, to do with each other and proceeds to the analysis of two dreams alleged to be telepathic, after stating that he had never had a telepathic dream of his own nor a patient with a truly telepathic dream in his twenty-seven years of analytic work.

The two cases which he gives are too long to recount more than sketchily. In the first, a man dreamed that his wife had given birth to twins, and the next day a telegram came saying that his daughter had been delivered of twins. With relatively few associations but with masterly powers of induction and with a regard for the rules of evidence which would kindle the admiration of the most meticulous lawyer, Freud shows this to have been precisely the type of dream one might have expected in this person and was simply a dream like any other, expressing a wish, which in this case was luckily fulfilled in reality. The second case is even more of a tribute to Freud's intellectual keeness; it is a more elaborate study of a girl who had many neurotic mechanisms of peculiar interest, such as the ability to learn a foreign language by reading it over, obsessional dreams and the like, who in this instance wrote Freud of an experience in which she and her mother simultaneously heard the voice of her brother calling at the very time that he was being killed in the war. Freud postulates on what seems to be excellent evidence that what happened was that on hearing the mother tell of her message (which Freud wisely comments that it is not incumbent on him to investigate or explain here) the daughter developed a conviction of having had the same experience at the same time, that is, the familiar memory falsification of the positive type. That this is supported by psychanalytic findings of family loves and jealousies centering about the Oedipus complex is then demonstrated.

"Telepathy has no relation to the essential nature of dreams," although "psychoanalysis may do something to advance the study of telepathy." Yet Freud disclaims any inclination to support the reality of telepathy in the occult sense; "for I have no opinion; I know nothing about it."

A few side remarks of the author are worthy of some attention. One concerns a discussion of the multiple interpretations of the same dream, for example, Silberer's classification into anagogic and psychoanalytic contents. Freud thinks that this is rarely possible and that no valuable example of such a dream analysis has been published up to the present time to his knowledge. This will be discouraging to the adherents of Jung.

The other note of interest is best quoted. "Spontaneous cures of neuroses usually leave scars behind, and these smart from time to time. We are very proud of our art if we achieve a cure through psychoanalysis, yet even so we cannot always prevent the formation of a painful scar in the process."

MENNINGER, Topeka, Kan.

ABNORMALITIES OF THE VISUAL FIELDS. INGHAM and LYSTER, J. A. M. A. **82**:17 (Jan. 5) 1924.

The authors make an appeal for more accurate perimetric determination of visual fields and enumerate the possible sources of error in the present methods of visual field determination. They prefer the use of binocular fixation and have devised a special screen with which this may be made.

Nine cases are reported which showed visual field disturbances: The first case was a right homonymous hemianopia, believed to be due to a tumor of the left visual cortex, although exploration failed to reveal the tumor, and further report on the case was not made. The second case was one of bullet wound in the occipital region. A loss of both lower fields was reported from one observation made without apparatus, the patient leaving the hospital before further studies could be made. Case 3 was one of brain tumor in the left frontal area which gave concentric peripheral contraction of both fields of vision and bilateral enlargement of the blind spots more marked on the left side where it extended into the macular region. Case 4 was one of pansinusitis, showing bilateral enlargement of the blind spots with concentric contraction of the fields, "apparently the result of damage to the optic nerve secondary to chronic infections." In Case 5, the fields showed incomplete asymmetrical homonymous hemianopia. "This patient was under observation for only a short time and a complete neurologic diagnosis was not established. A tentative diagnosis was made, locating the lesion in the neighborhood of the optic chiasm because of the asymmetrical homonymous hemianopia." In Case 6, the visual fields showed greatly enlarged blind spots which partially included the fixation areas. The neurologic examination was negative, and as the patient had been working for several weeks on the distillate tanks of an oil refinery and enjoyed remission from his visual defects, the case is considered one of toxic etiology producing a retrobulbar neuritis. Case 7, was that of a man aged 41, who sustained a depressed fracture in the right parietal area. Left homonymous hemianopia was present with concentric contraction of the visual fields. The lesion was on the right side of the brain posterior to the primary optic centers. A concentric contraction found "is to be explained by damages to the optic nerve from previous intracranial pressure." Case 8 was one in which the left blind spot was increased by a retinal degeneration or neoplasm close to the optic nerve. Case 9 was one of hemorrhagic glaucoma in which there was a contraction of the field of vision and slight enlargement of the blind spot, together with restriction of the color field in each eye.

TEMPLE FAY, Philadelphia.

THE LATE MENTAL SEQUELAE OF EPIDEMIC ENCEPHALITIS (LETHARGIC ENCEPHALITIS). J. SANCHIS-BANUS, Arch. de neurobiol. **3**:225, 1922.

The author discusses chiefly the late mental sequelae of epidemic encephalitis, feeling that while the neurologic aspects of the disease have been elaborately reported, mental symptoms have been comparatively neglected. A summary of the literature treating of these mental symptoms is given. Six personal observations are reported. Clinical histories of three of these cases are given, while the remaining three are referred to as cases with similar histories. Of the cases described, one was a man aged 43, who after a period of thirty-two days had recovered from the principal symptoms of the acute stage, of epidemic encephalitis, although frequent violent headache and ocular symptoms persisted a while longer. Four months later, however, a new set of symptoms made

their appearance, among which were psychomotor retardation and masklike facial expression. These are stressed in the author's discussion of this case, but it is not clear to the reviewer in what way the case differs materially from the parkinsonian syndrome so frequently noted after epidemic encephalitis. The second case described was that of a boy of 14. During the acute stage, lethargy was marked. After three weeks he had improved so much that he was regarded as having recovered, but he soon began to show character changes. He was irritable, suspicious, selfish, showed great dislike for his sister, was generally disobedient, displayed atrocious manners, masturbated and was restless at night for lack of sleep. There was, however, no apparent intellectual impairment. The third case was that of a young man, a student in engeneering, aged 26, who twenty-four days after he had been considered as having recovered from the somatic disorders, developed an intractable insomnia and began to show character changes. He suddenly decided to give up engineering and instead to prepare himself for a musical career by taking singing lessons. This he did against the violent opposition of his family and went his way without their aid. A year later he returned to his home after his sojourn in another city very much depressed over his failure as a singer. The insomnia persisted.

The conclusions drawn by the author follow:

(1) There is a type of mental disorder following late after epidemic encephalitis, particularly in young persons, which is independent of the clinical symptoms of the acute stage and general constitutional make-up of the patient and which is not accompanied by neurologic signs. It is characterized by insomnia and character changes.

(2) Schizophrenia is not a sequel of epidemic encephalitis. So-called post-encephalitic praecox, although developing after an encephalitis, is not a part of the encephalitic disorder but is precipitated by it. Some of these late mental cases on cursory examination may lead one to suspect dementia praecox, but closer study will reveal other symptoms of a different nature.

(3) There is a third group of post-encephalitic mental disorder without characteristic symptoms because the clinical manifestations in each case is to an important degree influenced by the general constitutional make-up of the patient and his particular type of mental reaction.

(4) Finally, there is a group designated by Naville as bradyphrenia. These bradyphrenics are also bradykinetic—a mental picture characterized by apathy, retardation, lack of spontaneity and disturbance of the will. It is hard to say that the bradyphrenic syndrome is entirely dependent on a bradykinesis, for only 16.5 per cent. of the bradykinetic patients are bradyphrenic. The relationship between the two has not been satisfactorily explained.

FULLER, Boston.

SOME MECHANISMS WHICH DISTINGUISH THE CROWD FROM OTHER FORMS OF SOCIAL BEHAVIOR. EVERETT DEAN MARTIN, J. Abnorm. Psychol. **18**:188-203 Oct.-Dec.) 1923.

Martin thinks Le Bon "started out with a social prejudice" and in spite of his ingenious descriptions made erroneous formulations of theory which are "rather old-fashioned today although much of it persists in different terminology in the writings of Trotter, MacDougall and Jung." Martin thinks the crowd can be better understood by considering some of the findings of psychanalysis, and he cleverly cites the example of the overwhelming defeat of John P. Mitchel for mayor of New York in which the phenomena known as substitution and rationalization were evident and are elaborated in detail. He thinks the charac-

teristics of the crowd mind uniformly present are: the closed system of ideas which the crowd substitutes for the facts of experience (better known to the Freudians as the substitution of pleasure thinking for reality thinking); the fixity of these ideas and of the propaganda, dogma and creed of the crowd, comparable to the manifestations of paranoia. Again the crowd derives much satisfaction from the unconscious self-flattery which praise of the whole gives to each individual. The crowd is exhibitionistic and, assuming this superiority to compensate for the inferiority of its members, it is favorable to the development of delusions of grandeur and delusions of persecution. This is the phenomenon of projection well known to psychopathology. "Every crowd is either actually or potentially homicidal. The crowd's rationalizations provide it with a mechanism which permits its members to indulge with a good conscience in acts of torture, killing and destruction. . . . Some one has said that the electorate does not vote for its candidate but against the candidate of the opposition." (In a sense this is just opposite to Freud's theory; the crowd is held together not by hate, but by love; Freud's theories of ambivalence, however, provide for a compensatory hate to match any given love expression.)

These characteristics Martin summarizes as collective egoism, homicidal tendencies and a closed rationalized creed. "The mechanisms of crowd behavior are, therefore, devices for creating a pseudo-social environment in which certain repressed wishes may escape from control."

The last few pages of Martin's article are an excellent critique in brief of Trotter, Rivers, Watson, MacDougall and Hocking. He decries the use of the phrase "group mind." "My thought may be about my neighbor and his about me but . . . there is no mingling of subjects and objects. My thought may be like my neighbor's . . . but similarity is not identity . . . There is no more reason for believing in a collective mind than in a collective stomach. . . . Conflict between the organism and its environment is avoided, but it reappears in the unconscious as conflict between the socialized consciousness and its repressed desires. The neurotic seeks to solve the problem by symptoms which express the repressed wish in disguised form. The crowd solves it by substituting for the true social situation, a fictitious environment in which the moral principles of social control are made to appear to justify the very sort of behavior that they normally inhibit."

MENNINGER, Topeka, Kan.

THE IMPERCEPTIBLE OBVIOUS. PAUL WILSON, Rev. de psiquiat. 1:27, 1922.

"The man who can't see the obvious is a chump, and the one who explains is a bore: there are two kinds of people in the world, and efficiency men belong to the latter group," with this sentence Wilson begins a discussion of the imperceptible obvious. He admits, however, that the foregoing quotation was "a cynical expression to the vulgar viewpoint" which he had uttered some time back and was for "polemical purposes." The main point of this discussion as the reviewer sees it is the ease with which the obvious may be overlooked. As an illustration of his contention, Wilson employs the psychanalysis *aliquis* by Freud, an impromptu analysis resulting from conversation with a fellow traveler on a railway journey, detailed in the second chapter of the "Psychopathology of Everyday Life" and no doubt familiar to all Freudians. A young Jew lamenting the hardships imposed on his race had quoted incorrectly from the Aeneid Dido's vengeance of Aeneas: *"exoriare ex nostris ossibus ultor"* instead of *"exoriare aliquis nostris ex ossibus ultor."* The suppression of *aliquis* it was determined was motivated by the fear that his sweetheart was pregnant, and in the associations "liquid blood," etc., are "profusely overdetermined."

The young man later explained that in his attempts to recall the suppressed word *exoriare* had "obtruded itself with particular distinctness" and "by association he gave the word *exorcism.*" If a colloquialism be permitted, right here, according to Wilson, is where Freud falls down when he regards the reinforcement of *exoriare* as a substitution for the suppressed word, "coming probably through the association of *exorcism.*" Wilson then asks somewhat triumphantly, "Could you possibly think of a better symbol for abortion than *exorcism?*" As a test he makes a diagram of Freud's *aliquis* analysis, "adding some links to connect the *exoriare-exorcism* phase with the *aliquis associations.*" The test analysis is certainly an ingenious thing as indeed are all such analyses as have come to the reviewer's notice. In view, however, of Wilson's opening sentence quoted above and his closing paragraph quoted below, one wonders why he went to the trouble to explain what was so obvious.

"Why did not the master analyst see the obvious? Why did the greatest of the efficiency men spend long periods in analyzing and perfecting certain manual movements, when the movements themselves were superfluous? Why does the interminable process of trial and error that makes up our daily life amount chiefly to the repetition of old errors? These questions, and many more, are all embodied in one and the answer is obvious."

FULLER, Boston.

SOME REMARKS ON TOBACCO. ERIC HILLER, Internat. J. Psychoanal. **3**:475-480 (Dec.) 1922.

This exceedingly suggestive collection of symbolic values of tobacco was written to supplement Brill's article which appears in the same issue of the journal.

The author first points out that tobacco may symbolize feces because it is also brown, has a characteristic odor, should be moist, is packed tight, and its use is frequently associated with a digestive function (that is, constipation appearing with abstinence). Tobacco and tobacco smoke may symbolize semen, for which the author gives certain explanations, and points out that the disgust for tobacco smoke on the part of many women is probably in part a fear of impregnation and is strongly suggested in the idea that the smoke will "get into the furniture."

That cigarets, cigars and pipes may symbolize the penis is possible because of their shape, the hot red end, the emission of smoke, the size, the position in which they are held, and finally the trick cigars sold as practical jokes, for example the cigaret which continually stands on end when laid down, the cigar which squirts water, the cigar which explodes like fireworks and the cigar which, when blown, expands to enormous size. The offering of cigarets and cigars between men is a ceremony of obvious significance with many subtle phases which the author cites with keen observation and with obvious interpretations, too numerous to quote.

Further symbolic significance may be derived from the fact that the cigar or cigaret is usually held in the hand, while some people feel an aversion to holding it in the hand and use a holder. Smoking is often done conspicuously as a form of exhibitionism. Some men try to persuade unwilling women to smoke, a solicitation (symbolically) for her to show her penis (a common childish phantasy). Again, learning to smoke is an assumption of manhood on the part of the lad (also the woman)—they acquire a real penis.

MENNINGER, Topeka, Kan.

THE SIGNIFICANCE OF STEPPING OVER. GEZA ROHEIM, Internat. J. Psychonal. **3**:320-326 (Sept.) 1922.

Roheim is impressed by the symptoms in Sokolnicka's case because of the fact that the same feature of assigning symbolic significance to the act of stepping over is to be found in the folklore of many peoples. The superstitions and rituals of this sort current in Holstein, Mecklenburg, Silesia, East Prussia and Thuringia, Wetterau, Brandenburg, Baden, Swabia, South Africa, various countries in Hungary, Baganda, India, Yorkshire and elsewhere are collected and their obvious relationship demonstrated. For example, "One must not pass a child through a window or it will stop growing," "A person who is still growing must not step in or out through a window unless he returns the same way," "A child must not crawl between anyone's legs, or if he does he must crawl back again," etc. In South Africa, stepping over another person is regarded as highly improper, but in some countries, as in Hungary, the husband steps over the wife to accelerate birth; it is significant that if this does not avail sufficiently, the husband has intercourse with the woman in labor. Stepping over thresholds is variously interpreted in various countries but it is related to the symbolic significance of entering the vagina (i. e., coitus, and rebirth). In many countries a dead baby or the placenta is buried under the threshold.

Whatever interpretation is made of the numerous occurrences of a similar idea, this collection is sufficient to demonstrate its ubiquity.

The reviewer would add that in the United States there is a couplet well known to all school children to the effect that one may "step on a crack and you'll break your mother's back," and it is also accounted bad luck to step on the cap to gas or water mains.

MENNINGER, Topeka, Kan.

BRAIN LESIONS OF THE DOMESTIC RABBIT. JAMES E. MCCARTNEY, J. Exper. Med. **39**:51 (Jan.) 1924.

McCartney examined microscopically the brains of 372 rabbits dying from various affections as well as those sacrificed in apparent health. None of the animals had ever been inoculated intracerebrally. Of these brains, 55 per cent. showed lesions of meningo-encephalitis, infiltrations with mononuclear cells occurring about blood vessels of the meninges, in the cortex and under the ependyma of the lateral ventricles; in some instances focal necrotic areas were found in the cortex. In rabbits apparently normal these lesions were found in 40 per cent.

The work presented here was undertaken in part to estimate the value of experimental work directed toward the causative agent of epidemic (lethargic) encephalitis. McCartney allows one to infer that previous work on this disease based on the study of rabbit inoculation has not been properly controlled by parallel studies on supposedly healthy rabbits and that the lesions described as characteristic of encephalitis are present in the rabbit before any experimental work is done.

VONDERAHE, Cincinnati.

RESCUE AND MURDER OF THE FATHER IN NEUROTIC PHANTASIES. KARL ABRAHAM, Internat. J. Psychoanal. **3**:467-474 (Dec.) 1922.

Phantasies in which the individual conceives of himself as rescuing the father or mother from danger of death are common in neurotic persons. Freud had previously studied these (also Rank and Harnik), and their occurrence in romance and poetry is well known. The explanation offered is related to the

Oedipus complex, but needs some elaboration. This Abraham supplies. He first cites a case which seems to be the opposite of the Oedipus theme; a man stops a runaway carriage in which sits the king, thus saving his life. He analyzes this in great detail; finding that the pair of horses represent the parents, the act of driving them and also their bolting representing coitus and therefore the intervention of the son a prevention of parental intercourse. This illustrates how a dream may signify the exact opposite of its apparent content; thus rescue is really significant of killing. In connection with this phantasy Abraham recalls from the Oedipus myth a similar scene in which the king travels proudly in a carriage, accompanied by a driver, herald and two servants. They endeavor to force Oedipus out of the way as he advances toward them but he resists, striking the driver. The king then strikes Oedipus with his thorny stick and Oedipus in returning the attack kills him. Abraham analyzes the various features of this account, calling attention to the phallic signficance of the stick, which is made particularly dangerous, and to various other items of analytic significance.

MENNINGER, Topeka, Kan.

TOBACCO AND THE INDIVIDUAL. A. A. BRILL, Internat. J. Psychoanal. **3**:430-444 (Dec.) 1922.

Brill recounts the history of the use of tobacco from its introduction by Jean Nicot. He believes the tobacco habit in various forms represents a symbolic satisfaction of various significances according to the individual, but in general a regression to the stage of auto-erotism. This he justifies by referring to the prominence of the mouth function in the use of tobacco, the various uses made of tobacco and of chewing and smoking generally by savages, and by the analysis of neurotics in which the use of tobacco figured prominently. He regards the use of tobacco by the average individual as "an excellent outlet," and says he has never seen a single neurosis or psychosis that could be definitely attributed to its use.

MENNINGER, Topeka, Kan.

FESTSCHRIFT FOR CONSTANTIN VON MONAKOW. (EDITED BY O. VERAGUTH, M. MINKOWSKI AND R. BRUN), Schweiz. Arch. f. Neurol. u. Psychiat. **13**: 1-24, 1923.

This Festchrift is dedicated to Constantin von Monakow in commemoration of his seventieth birthday, Nov. 4, 1923. It is a just and fitting tribute to so great a man. The volume is an octavo of 709 pages and comprises fifty-two publications by neurologists of many different countries. A portrait of von Monakow appears in the front of the book. The introductory address was given by Dr. C. Winkler, of Utrecht, in which he emphasized the significance of von Monakow contributions to science. His most important contributions are referred to briefly, particularly his work on the cortical representation of different nuclei of the thalamus, on the vestibulospinal and rubrospinal tracts, on the cortical representation of the macula, on the importance of considering the evolution of functions as related to architectonic and clinical studies, on the doctrine of diaschisis, on the autonomic nervous system and the chromaffin and endocrine systems, and finally on the great inspiration and enthusiasm with which he imbued his colleagues and students, and the kind hospitality of the man himself. Von Monakow has published articles appearing under 107 different titles.

WOLTMAN, Rochester, Min.

ANALYSIS OF AN OBSESSIONAL NEUROSIS IN A CHILD. EUGENIA SOKOLNICKA, Internat. J. Psychoanal. **3**:306-319 (Sept.) 1922.

A boy, aged 10½ years, with many severe obsessional symptoms, chiefly of the ceremonial kind, was treated over a period of six weeks by the author, not by psychoanalysis in the strict sense of the word, but by a combined analytic and pedagogical study, with at least temporary cure—the author being conservative in deciding this point. The symptoms were too numerous to detail, but they concerned great distress caused by having one object placed on another or some obstacle in front of an object which was to be moved; while eating, every mouthful was spat out one or more times into his mother's hand until it was properly put into his mouth; everything had to be touched with both hands, and if a mistake occurred and a thing was touched with one hand only, a ceremonial had to be gone through with for propitiation.

The significance of all of these symptoms was elucidated by a study of the patient's dreams and his associations to them, which revived relevant memories.

The chief value of the contribution might be supposed to lie in the technic which is given frankly, and which in this case apparently had advantages over the ordinary psychanalytic procedure.

MENNINGER, Topeka, Kan.

FURTHER DATA CONCERNING SEX DIFFERENCES. HENRY T. MOORE, J. Abnorm. Psychol. **17**:210-214 (July-Sept.) 1922.

In studying the mental differences between the sexes, the author adopted the ingenious device of "walking slowly up Broadway from Thirty-Third Street to Fifty-Fifth Street at about seven thirty every evening" and jotting down every bit of audible conversation. These he classified both as to speaker and listener and as to the topic of discussion. A hundred and seventy-four fragments were jotted down, many of which are quoted in the text. The table permits obvious interpretations.

	Man to Man	Woman to Woman	Man to Woman	Woman to Man
1. Money and business	48%	3%	22%	12%
2. Amusement	14%	4%	25%	10%
3. Persons of same sex	13%	16%	13%	13%
4. Clothes, buildings, interior decoration	2%	23%	3%	17%
5. Persons of opposite sex	8%	44%	10%	22%

MENNINGER, Topeka, Kan.

Society Transactions

PHILADELPHIA NEUROLOGICAL SOCIETY

Regular Meeting, Feb. 29, 1924

C. W. Burr, M.D., *President, in the Chair*

Psychoneurotic Manifestations in Dermatology with Particular Reference to Treatment with Suggestive and Educative Measures. Dr. Joseph V. Klauder.

Psychotherapy may be of considerable value in the treatment of certain skin diseases, objectively as well as subjectively manifested. A psychic cause of such common skin diseases as pruritus and urticaria should be included among the many causes of these diseases. Not only is psychotherapy of value in the treatment of the psychogenic types of the aforementioned diseases, but also in other conditions encountered by the dermatologist. Such conditions as neurotic excoriations should be considered, as for example, trichotillomania, trichokryptomania, and dermatothlasia.

In a consideration of the psychogenic skin diseases, reference should be made to reported cases in which a variety of acute skin lesions occurred in hypnotized and hysterical patients following suggestion. Skin diseases in which no specific cause is known, such as eczema, psoriasis, dermatitis herpetiformis, the hair turning suddenly white, discolored sweat and angiospasm of the fingers (so-called "dead fingers"), sometimes occur acutely after severe mental shock.

The purpose of this presentation is more concerned with psychic cutaneous reactions amenable to psychotherapy, of which the following case is an example. A young man complained for some months of flushing of the entire face after shaving. The alternative of an unshaved or a reddened face caused considerable embarrassment. He had been previously treated with local applications, without avail. The psychogenesis of his complaint was clearly explained to him, and he was told that if he could go about the act of shaving the following morning oblivious to the consequences of his prior acts of shaving, he would be cured of this reaction; after this the flushing rapidly disappeared, and he has remained free of the reaction for three years.

There are many etiologic factors in pruritus and urticaria, the following cases being examples. A boy, aged 12, developed pruritus following the bite of an insect. A male school teacher, aged 24, complained of pruritus of the trunk, which appeared each afternoon at 4 o'clock. A convict recently arrived at one of the state prisons experienced a severe attack of urticaria each time he was locked in his cell. No treatment other than psychotherapy was employed in the treatment of these patients, and the complaint rapidly disappeared.

Following is a brief history of the patient presented. A widow, aged 40, who was supporting herself and her family, endeavored to educate her two children. She taught school day and evening, and between sessions did housework. She kept books on Saturday, did housework on Sunday, and worked during summer vacation. She complained of being tired most of the time, and had three and four daily attacks of urticaria. She was the type of person

who works under a "nervous tension." Her urticaria was not regarded as psychogenic unless possibly it arose from an anxiety state, but was thought to be an expression of a fatigue neurosis. Many measures were employed in treatment, together with educative measures which were directed at training herself to work mentally relaxed. She made a complete recovery from her urticaria and declared that she believed training herself to relax was an important factor in her cure.

The second patient, a man, aged 38, had acarophobia which developed following an attack of scabies. Following psychotherapy, he no longer thought his skin was infested with parasites, but he now believes it was dirt under his skin which produced the severe pruritus of which he complained.

A third patient, a man, aged 40, had unilateral sweating, the perspiration being brown. This was apparent in the manner in which it discolored his clothing.

DISCUSSION

Dr. Arthur Van Harlingen: The first book on medicine I ever read was Tuke's "Influence of the Mind on the Body." In that book there was a description of a man, who, by fixing attention on his great toe, could bring it to a state of redness and finally sweating and inflammation. Many years afterward I became interested in hysterical manifestations in the skin and collected nearly 150 references to about twenty diseases which were connected with hysterical conditions, such diseases as erythema, urticaria, pemphigus, dermatitis, gangrene, various conditions of the sweat glands, bromhidrosis and chromhidrosis. I was interested in the history of a Belgian, an hysterical girl, who dwelt long on the case of Jesus Christ and St. Francis, and finally developed lesions in the palms of the hands, in the side of the body and soles of the feet. She created a great deal of interest among the medical men and theologians of Belgium, and was carefully watched. One physician who watched her most carefully said that before the eruption began at 12 o'clock noon on Friday, the palms of the hands seemed perfectly healthy, and a little while afterward an erythema appeared in the palm of each hand; then the skin rose and by 2 or 3 o'clock the skin had broken and blood began to pour from each point. The case was beyond question not one of fraud. Several years afterward she was on exhibition; a great deal of attention was paid to her, and finally after a year or two the affection died away, and she imitated it. Of course, to the practiced eye it was not the same. Autosuggestion started it, and it might have yielded to suggestion by a physician. I know one case in which blood would come from the nipple, that was gradually cured by suggestion. There were a number of children at the Church Home for Children with an epidemic of crowing. The children began to act as if they had whooping cough, and it spread rapidly. Dr. S. Weir Mitchell was called in, and he had a great deal of trouble stopping the conditions. Some years afterward, one of the girls was a domestic in my household, and she presented herself to me one day, with an eruption resembling superficial gangrene on the arms and neck. I did not know her history at that time. I found that she was entirely unaware that she had herself produced anything and was very much ashamed of the eruption, which passed off after a while. Although this young girl did not know, or at least did not admit the fact, she probably started the disease by rubbing; at the same time, she certainly had no intention of exciting an eruption.

Dr. Francis X. Dercum: We have all seen various cutaneous manifestation in hysteria. Long ago, I came to the conclusion that they were artefacts. I can recall many instances; e. g., one in which a girl whom I had under observation presented an ulcer of the forearm which in spite of adequate surgical care did not heal. The late Dr. Henry W. Stelwagon agreed with me that the ulcer was an artefact. I finally had the ulcer dressed surgically and then a plaster of Paris dressing applied from the hand to the elbow, after which the ulcer promptly healed. A similar, though a much more pronounced case, was that of a girl who had had an accident in which she received a burn from lye, which consisted of a small excoriation on the back of the left hand just at the junction of two of the fingers. She was the youngest child of a large family and had never received any special attention. Suddenly she became the object of great interest. Her hand was examined and physicians were called in, but the burn refused to heal. Other physicians were consulted; the patient was taken to various hospitals until finally she reached my wards at the Jefferson Hospital. Other ulcerations had now made their appearance; some on the left forearm, others on the left thigh, but all the ulcerations were on the left upper or lower extremities. The patient presented the symptoms of a pronounced hysteria, and it appeared that as fast as an ulcer would heal, she would make a fresh application of lye. Before these facts became known to me, I charged the patient with producing the ulcers and voluntarily maintaining them. At first she indignantly denied the charge, but finally broke down, wept and admitted what she had been doing. I need hardly state that the ulcerations rapidly healed under simple surgical dressing. I have always been doubtful as to the genuineness of some of the older reported cases. I have always regarded the manifestations produced as artefacts, in other words, as results of deliberate effort to attract attention, wonder and sympathy. Among the many thousands of cases of hysteria that I have observed, I have never found any reason to change my opinion. When the patients are put under close observation and are charged with the voluntary production of the symptoms, the symptoms disappear. It is a fact, too, that we see cutaneous manifestations in hysteria with increasing rarity — for instance, the so-called "blue edema" of hysteria we now see rarely.

Some of the cases shown by Dr. Klauder suggest the phobias seen in psychasthenic persons. The man whom he presented, and who spoke of feeling grains of sand in his skin, is very much like the patient who constantly feels and observes filth and vermin on his person; in other words, this patient suggests a condition similar to the mysophobia observed in some psychasthenic persons. Red chromhidrosis, however, such as is presented by one of these patients, cannot, I think, be regarded as a nervous manifestation. One can readily understand, on the other hand, how the occurrence of chromhidrosis in a hysterical woman might be taken advantage of and might to inexperienced persons suggest bleeding.

As regards hysteria, we should bear in mind that since the explanation advanced by Babinski some years ago of the rôle of suggestion in the production of the symptoms, we need not be surprised in meeting the most bizarre conditions.

Dr. D. J. McCarthy: Most of these cases, as Dr. Dercum has suggested, are open to question. Many years ago I saw a woman with a tumor of the spinal cord. About a year later, the daughter developed a tumor in the left popliteal space as big as an orange. Preparations were made for its surgical removal; then there was found an area of stocking anesthesia around the knee.

The application of faradic current and suggestion caused the whole condition to disappear. I think a case of that kind is definitely on an hysterical basis; it could not be produced artificially. These cases from the functional standpoint unquestionably do occur. The group of urticaria cases are open to question. Urticaria may be due to the intestinal disorders that occur frequently in ordinary neurasthenic conditions, and we do not consider them as vasomotor, but due to toxemia. As to the other group of cases, I have three patients under my care with delusions of insects in their skin. The delusion there is only a manifestation of the underlying insanity.

Dr. Alfred Gordon: Babinski claims that various skin conditions in hysteria are produced exclusively by artificial means. In *Revue Neurologique*, No. 18, 1908, I reported the history of a young girl, aged 27, who was poor and anxious to get work. Her parents were abroad, poor and sick, and she had to send them money. In addition to various mental and physical manifestations of hysteria, every time she received a letter from her parents reciting the miseries they were undergoing in Hungary, she would get cardiac palpitation, and the next day an erythema would appear on her breasts. The erythema was symmetrical. The question of fraud could be absolutely eliminated.

Two Cases of Peripheral Facial Paralysis Associated with Symptoms of a General Infection. Dr. Williams B. Cadwalader.

My object in presenting these two patients with peripheral facial paralysis is to call attention to the relationship of an acute infection as a cause of peripheral facial involvement. The usual causes, exposure to cold and wet, and middle ear disease, were not present. In each case, repeated attacks of tonsillitis had occurred.

Case 1.—The patient, aged 8, on Jan. 10, 1924, complained of headache, muscular pain, fever, repeated vomiting and malaise. The next morning it was noticed that he had weakness of the right side of the face. This continued, and also occasional vomiting, headache and muscular pains. The tonsils were enlarged and infected. No symptoms of intracranial disease were present.

Case 2.—The second patient, aged 7, had had frequent attacks of tonsillitis. On Jan. 10, 1924, he had severe coryza and went to bed. The next morning he vomited, had headache, malaise and fever. Five days after the onset, he developed weakness of the lower portion of the right side of the face. Ten days after the initial symptoms, the upper portion of the right side of the face was also paralyzed. He still complains of pains in the muscles of all four limbs and his back. Dr. Randall reported that the ears were normal and that the tonsils were severely infected and enlarged.

The slow onset of peripheral facial paralysis associated with the symptoms of a general infection, without ear disease, refrigeration or signs of intracranial disease, is unusual. The relation to poliomyelitis or encephalitis is suggested, but there are no other symptoms indicating these conditions.

The patients have no family relation to each other.

DISCUSSION

Dr. J. Hendrie Lloyd: These cases are of great interest, if we can rule out exposure to cold and ear disease as possible causes. Facial paralysis is rare, I think, as a result of infection. Some years ago Dr. H. T. Patrick, of Chicago, reported a case of bifacial paralysis in alcoholic multiple neuritis.

Occasionally we have facial paralysis in basilar syphilis invading the cerebropontile angle, but in other infections I do not recall having seen facial paralysis. It has been reported in lethargic encephalitis, of which there seems to be no evidence in the present cases.

Dr. C. A. Patten: My remarks may not be strictly a discussion of facial paralysis, but they concern an epidemic type of affection somewhat in the nature of a neuritis. Recently there has come to my attention a number of patients complaining of arm, shoulder and pectoral pains. For the past few weeks, a considerable number of such patients have reported at the Orthopaedic and Polyclinic Hospital dispensaries, and internists with whom I have talked about the matter say they have encountered a great number in their own practice. The condition complained of is severe pain radiating down the shoulder or arm, across the chest, attended with some fever, malaise and a good deal of tenderness over the muscles and nerve trunks. The pains are of such severity that the patient is unable to sleep at night, and requires considerable medication for relief. Fairly definite response is obtained through rest and large doses of salicylates. Laboratory findings and roentgen-ray reports in all cases have been negative.

Under such circumstances, I think we must consider not only epidemic forms of grip and allied conditions, but also atypical types of encephalitis manifested largely by neuritis. In regard to Dr. Cadwalader's case, the same question may be raised.

Dr. Alfred Gordon: The gradual development of palsy, fever and pain (due to infection) suggest a nuclear lesion. Very likely these are cases of encephalitis or polio-encephalitis.

Dr. W. B. Cadwalader: I have nothing to add except the statement that in one case the paralysis began in the lower part of the face five days before the upper part was paralyzed. This is the statement of the mother; I could not confirm it, but I believe it to be true.

A Case of Tumor of the Hypophysis, with Exhibition of the Brain. Dr. J. H. Lloyd and Dr. F. C. Grant.

This article will be published in full in the Archives of Neurology and Psychiatry.

The Rôle of the Thyroid Gland in the Growth of the Central Nervous System. Dr. Frederick S. Hammett.

The removal of the thyroid apparatus (thyroid gland plus the parathyroids) from albino rats of both sexes is followed by a retardation of the growth of the brain and spinal cord. The growth of the brain is consistently more retarded than is that of the spinal cord. This differential response to thyroid deficiency may possibly be an explanation of the apparently greater relative retardation of mental ability in cretins than is exhibited in the development of the physiologic functions as related to the spinal cord activities.

The greater retardation of the growth of the brain as compared with that of the spinal cord indicates a greater dependence of the former on the growth promoting functions of the thyroid gland. This greater dependence is interpretable on two interparticipating bases. The first is related to the fact that during the course of phylogenetic evolution the structure which gives rise to the spinal cord of vertebrates is laid down in characteristic form and composition independent of thyroid gland secretion; while the evolution of the

brain, that is to say, the cerebral hemispheres, is accompanied throughout its entire course by the thyroid. Hence the implication arises that the growth of the spinal cord is normally largely independent of thyroid gland function, while that of the brain is largely dependent thereon, and therefore when a thyroid deficiency is initiated the growth of the former is less disturbed than is that of the latter. The second basis of interpretation lies in the well-known difference in chemical composition of the two structures. The brain is an organ of high protein and low myelin content; the spinal cord is a structure of relatively low protein and high myelin content. It is evident that the chemical processes concerned in myelinization are more resistant to the growth-inhibiting influence of thyroid deficiency than are the processes concerned in growth by increase in cytoplasmic (protein) materials, otherwise the retardation of the growth of the spinal cord would be closely like that of the brain.

DISCUSSION

Dr. H. H. Donaldson: This table which Dr. Hammett has presented represents one set of records from a series of age groups, in part complete, but fully planned. When the series is completed, it will be possible to say how the loss of the thyroid affects the development of the nervous system, as the thyroid is removed at earlier and earlier ages in each successive group. Further, I wish to make two points: one is that these figures at which you have been looking are based on an adequate supply of animals. They represent about 152 rats. Moreover, these results have been treated carefully by statistical methods. In each of the age groups the observations have also been made not only on the growth of the body as a whole, but on the development of the bones from the chemical standpoint, and on the development of the separate organs, the glands and the major viscera, and also on the more important physiologic functions, so that it is hoped that when these observation are completed we shall have a fairly accurate picture of what removal of the thyroid and the parathyroid from a rat at a series of intervals between birth and maturity means in that animal.

Dr. F. X. Dercum: I am not sufficiently familiar with the anatomy of the rat to speak definitely of the arrangement of the parathyroid and thyroid glands; i. e., whether we have in the rat two pairs of these glands and also occasional accessory glands, such as we have in other mammals. Are we to infer from Dr. Hammett's experiment that the parathyroids were removed as well? In some animals, the parathyroids are actually imbedded in the thymus, and if that is the case, deductions as to the effect of the removal of the parathyroids are hardly safe. I would like to ask Dr. Hammett whether his studies have shown any change in the thymus when the thyroid gland was removed. Do the animals show changes corresponding to parathyroid, thymus and thyroid deficiencies?

Dr. Frederick S. Hammett: In regard to the parathyroids: It is generally understood from Christiania that there are two parathyroids in the rat. The glands are sometimes aberrant. Those occurring in the neck can be detected during operation and removed. In 10 per cent. there are accessory parathyroids in the rat. However, we have used certain criteria as to whether the parathyroidectomy has produced a glandular deficiency. The normal animal grows in a uniform curve in this way from the time of observation to cessation of the experiment. The growth of the parathyroidectomized animals is retarded. The animals that follow the normal curve have shown no tetany at any time.

I have included in this study only those animals that have shown a depression of growth, tetany or dental defects. I know that we get parathyroid deficiency. In regard to the thymus, it is one of the organs of the body which loses weight enormously when the thyroid is taken out. Whether that is due to specific relation between the thyroid or to the general cachectic condition, I do not know.

CARCINOMATOUS METASTASIS TO THE CENTRAL NERVOUS SYSTEM. DR. E. A. STRECKER and DR. A. TAFT.

A man, aged 47, applied for treatment on July 30, 1923. He gave a history of loss of bladder control of ten days' duration, and said that he had been arrested five days before because of a staggering gait, which was mistaken for drunkenness.

Physical examination revealed the patellar reflexes greatly exaggerated on both sides and the Achilles slightly exaggerated, but there was no clonus or Babinski sign. The abdominal reflexes were diminished. There was a marked Romberg sign. Coordination was good in the upper extremities but defective in the lower extremities. There was no muscular atrophy; but some diminution to touch and pain on the back of the thighs and the internal aspect of the gluteal region was noted. Because of the suspicion of a bronchopneumonia in addition to the neurologic findings, the patient was admitted to the hospital. Eye examination revealed moderate arteriosclerosis. The blood count and blood smear were negative; the urine contained albumin and casts; blood and spinal fluid Wassermann reactions were negative, but there were eleven cells in the fluid with an increase of sugar. The preliminary neurologic examination revealed the fact that, in addition to the loss of bladder control, there was now absolute loss of bowel control; the patellar reflexes were still increased; but a satisfactory neurologic examination could not be made, nor could the sensory condition be determined on account of the profound dementia which prevented cooperation. It was noticed that there was a small tumor in the left axilla at the nineth and tenth ribs. A section of this tumor on examination resembled a carcinoma simplex with large regular cell columns and scanty stroma. It was considered metastatic. The roentgenogram of the chest wall was reported as follows: "There is gross pathology on the left side involving the entire lower lobe."

On Sept. 7, 1923, the patient's condition took an abrupt change for the worse, with evidences of physical collapse; later, on the same date, he had a convulsion. He groaned and his limbs shook; he was conscious and said he was cold. The attack lasted less than a minute. He had a second convulsion seven hours later. On the next day, the patient died in the third convulsion.

Necropsy revealed: Masses beneath the jaw on the left side, and on the right side two masses above the clavicle of about the same size, and several smaller ones; a shotty, pea-sized nodule in the second right interspace in the midclacivular line, and over the ninth or tenth rib on the left side, in the midaxillary line, an incision with protruding mass which pushed its edges open, not attached to the rib but palpable through the peritoneum. The lower part of the left lung was woodeny and nodular. There were two metastatic nodules embedded in the liver substance. There was a mass in the left retroperitoneal space 5 to 6 cm. in diameter, rounded in outline and cheesy in consistence. Neuropathologic examination revealed no gross lesions of the cerebrum, a large nodule in the cerebellum on the upper surface of each hemisphere, and two smaller masses surrounded by pial membrane depending from the posterior,

inferior margin. There was a small nodule in the left side of the inferior vermis. In the brain proper, there was slight fibrous thickening of the pia. While the cortical cells were fairly well maintained, there was a scattered thinning of the large pyramidal cells in many sections. In a section from the base of the right second frontal convolution, there was a microscopic area of softening of vascular origin. It is probable that an exhaustive search of the cortex would have revealed others. The vascular changes were only moderate and were seen chiefly in the smaller vessels as fibrous thickening. A few small round cells were occasionally present in the perivascular spaces. Throughout the white substance there were many small oval cells, not infrequently seen as a reaction to a chronic irritative agent of low toxicity.

A special study was made of an additional number of sections from the cortex and in one from the right midfrontal region; a small pinpoint metastasis was found in the white substance, some distance from the gray cortex, apparently having been carried there through the perivascular lymph spaces. Serial sections of the entire cortex would doubtless have revealed others. The one discovered was too minute to be seen in unstained sections.

The cut surfaces of these tumor masses were finely mottled black and white. They were very friable and granular and were easily broken up by handling. The cord appeared normal on gross examination, except at the lower extremity of the lumbar enlargement, where there was a mass of tumor tissue which had almost entirely replaced the normal nervous structure. It extended downward, including almost the entire conus. The cut surface had the same appearance as that seen in the other nodules. Microscopically, the tissue was made up of nests of large vesicular cells, embryonic in type. They appeared as undifferentiated epithelial cells, many of which were in various stages of cell division. Some areas were vascular, and in some the tumor cells were maintained only about the blood vessels, producing the so-called "perithelial" arrangement, with degeneration in those parts farthest from the blood supply. There was not sufficient cell differentiation in the tumor growth in the nervous system to justify a diagnosis more definite than rapidly growing metastatic carcinoma. A diagnosis of primary carcinoma of the lung was made.

MULTIPLE NEURITIS FOLLOWING CARBON-MONOXID POISONING: CLINICOPATHOLOGIC STUDY. DR. GEORGE WILSON and DR. N. W. WINKELMAN.

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NEW YORK NEUROLOGICAL SOCIETY

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E. G. ZABRISKIE, M.D., *President, in the Chair*

TWO UNUSUAL CASES OF MYOPATHY. DR. IRVING H. PARDEE and DR. I. MARGARETTEN.

CASE 1 (Dr. Margaretten).—L. G., a Jewish boy, aged 7, who had been under the observation of the Neurological Institute for four years, because he was disobedient, stubborn, inattentive and destructive, and he masturbated, was generally weak, unable to walk up or down stairs, to hold up his arms or to

grasp firmly. He had difficulty in swallowing and chewing, pain in the back of the neck, headache, sleeplessness and constipation, and was a mouth breather. These symptoms had a gradual development from infancy, the mental symptoms predominating. The patient was delivered with instruments; was weaned and had his first teeth at the age of 6 months; he had all his teeth at the age of 18 months; he walked at 14 months. He had colic as a baby. He had fallen against the piano striking his head, with no sequelae.

About January or February, 1923, there was an abrupt change in his condition. The mental abnormalities subsided somewhat, with increasing general weakness. He was strangled by a rope around his neck, and a few days later weakness in the lower extremities became apparent, and recently the upper extremities, eyes and chewing muscles became involved. The muscular activities were much weaker in the afternoon. About January, the mother noticed a lump in his neck which had progressively grown larger. The boy saw double at one time, but he had not done so recently. Speech and sphincters were not affected, although some of the relatives said that he had never articulated well. For six weeks he had complained of recurrent headaches which lasted a few days and then disappeared.

While in the hospital, these symptoms grew progressively worse. He was much stronger in the morning. There was less drooping of the lids. He fed himself more readily and swallowed, but choked as he ate, even with milk. He was restless during the day as well as during the night, used profane language and was untidy and disobedient. He left the hospital unimproved. After leaving, as he was gulping some tea one morning he coughed and choked until he expired.

Physical examination, April 28, 1923, revealed that the eyelids drooped, the mouth was open, the teeth irregular; he walked on his toes, acted the clown, was mischievous, cooperated, but was inattentive and restless; he had a weak hand grip. He was able to squat and rise, but when lying down he arose weakly and awkwardly. Reflexes, sensation, cranial nerves, associated, automatic and alternating movements and coordination were normal. The cardiovascular apparatus and viscera were normal.

On Jan. 3, 1924, he was well nourished and well developed. He sat on the bed with head drooping forward, with expressionless, flat, sallow, adenoid facies and ptosis. When standing, he assumed an attitude of dystrophy, i. e., genu recurvatum and lordosis. He had a feminine outline of the chest and pelvis, smooth, velvety, puffy skin, partially descended testes, faint temporal eyebrows, high arched palate and space, ragged teeth, small lateral incisors, and a large, thick tongue. He was able to stand or walk but soon tired and sank to the floor. He was unable to sit up and became fatigued after a few attempts. He could not hold his head erect; it fell forward or backward. There was marked hypotonia and asthenia in all muscles. There were no abnormal movements. Sensation was normal. All reflexes were hyperactive and became fatigued after repeated testing. There was a static Babinski attitude of the toes. The cranial nerves, with the exception of the motor, were normal. There was bilateral ptosis, and there were nystagmoid twitches in all extra-ocular movements. The jaw, facial, tongue, pharyngeal and laryngeal muscles were weak. There was no atrophy or hypertrophy anywhere. Faradic stimulation showed the myasthenic reaction. There was an enlarged thyroid with a nodule on the left lobe.

There was a relative lymphocytosis, 52 per cent., and a secondary anemia of 70 per cent. The Wassermann reaction was negative in the blood and spinal

fluid. The urine was highly acid with a high specific gravity. A roentgenogram of the chest did not show an enlarged thymus; the skull showed a small sella with a roughened outer edge and a heavy dorsum. The intelligence quotient in three tests was always 100 per cent.

In view of the gradually progressive condition, a pathologic thyroid ancestry and symptoms of a pituitary, thyroid, thymus, suprarenal and gonadal decrease, I consider the myopathy the result of an abiotrophic state. The mental and myasthenic symptoms may be in favor of encephalitis, but there were no remissions in this case, such as are common in encephalitis.

Case 2 (Dr. Pardee).—A girl of Jewish parentage, aged 13, in whom the arms and legs had become progressively weaker, had also ptosis of the eyelids. The reflexes were normal. The girl was fairly intelligent, but rather apathetic. She was under treatment in the Beth Israel hospital, where she was supposed to have congenital syphilis on account of a positive blood Wassermann reaction. This is the only time that it occurred. The Wassermann reaction in the parents was negative. The girl presented signs of an endocrine imbalance.

DISCUSSION

Dr. H. A. Riley: Is there any fatigability of the jaw reflex?

Dr. I. H. Pardee: No. We were not able to demonstrate fatigability of the muscles, but the patient says there is variation of the muscles. I have seen more ptosis, especially under emotional stress, as in being in this room. There has been no diplopia at any time. The abdominal reflexes are present.

Dr. E. G. Zabriskie: Case 2 seems chiefly remarkable for variations in fatigability of the musculature.

Dr. Abrahamson: Case 1 impressed me as being a myasthenic type of a chronic lethargic encephalitis—the bulbar death, the mental changes, the variability of the myasthenic phenomena and the tendon reflexes. Some type of endocrinopathy was present, but I do not regard it as the cause of the manifestations.

Dr. Pardee: The treatment instituted at the Beth Israel Hospital was antisyphilitic. The presence of a positive Wassermann reaction is suggestive of syphilis, but I do not think it is proved. I am glad to get Dr. Abrahamson's point of view, because I have seen cases of this type following encephalitis. From the standpoint of endocrine imbalance, this case fits into the type of status thymicolymphaticus. This does accompany myasthenia gravis. Sixty per cent. of these patients show persistent thymus at necropsy. This, combined with the low blood pressure, places her in that group definitely.

Neuro-Epithelioma of the Spinal Cord. Dr. John A. Hartwell (by invitation) and Dr. Lewis Stevenson.

The tumor used as the text of this discussion was entirely extra-medullary, originating beneath the pia arachnoid, the latter membrane passing over it and binding it closely to the cord. It was excessively malignant in type. A gliosis appeared, but seemed to be of later date than the tumor. The patient was a woman, aged 40; she had sustained an injury to the cervicodorsal spine, two years before onset of symptoms. The outstanding symptom was subjective pain in the distribution of the brachial plexus and of the second and third dorsal nerves, at first recurrent but not severe. Later it was severe, with no relief. She was first observed in March, 1922. At that time, there was tender-

ness over the second and third dorsal spinous processes and an area of hyperesthesia in the distribution of these nerves. There was some interosseal atrophy in the left hand. There were no alterations in the reflexes, no other paresthesias and no motor changes. The subjective pain was excruciating, without remission. On May 26, there was sympathetic involvement on the left side, shown by false ptosis and contracted pupil.

The diagnosis favored was cervicodorsal radiculitis with pachymeningitis, possibly due to infection from a tooth root. The question of neoplasm was raised, but evidence therefor was not deemed conclusive. Pain continued through the summer. In September, the right scapular region became painful; in October, there first appeared evidence of cord involvement. There was momentary weakness in the left lower extremity and paresthesia in the right thigh. In ten days, the picture had passed through a Brown-Séquard syndrome to an almost complete transverse lesion of the cord at the first and second dorsal segments.

Laminectomy discovered the tumor lying beneath the arachnoid, with maximal pressure at this region, and spreading upward and downward for a total distance of 10 cm., that is, from the fifth cervical to the third dorsal. There was also a very small tumor in front of the cord in a pitlike depression in the dura.

New growth, a soft, pliable, tongue-like piece of tissue, 4.5 cm. long, and 1.25 cm. wide, 4 mm. thick, tapering off toward the ends, was present. The tissue resembled splenic tissue in appearance. The outer surface was smooth and glistening, the under surface coarsely granular. The growth appeared to be composed of congeries of blood vessels, leading to a tentative diagnosis of endothelioma. The smaller tumor was isolated and to the eye not connected with the main growth. It was partly blood clot, partly tumor tissue. Pathologic report by Dr. Elser.

The wound healed by primary intention, and there was definite improvement in all ways for about four weeks. Thereafter there was rapid retrogression, with varied cord manifestations, until death, seven weeks after the operation, from complete transverse myelitis.

At necropsy, a recurrence of the tumor, measuring 4 cm. long and 5 mm. thick, was found, which strikingly resembled the original tumor. There was a compression myelitis of the cord. There was considerable straw colored fluid below the site of the operative field; otherwise the cord below appeared normal. Bacteriologic examination of this fluid was negative.

A detailed pathologic examination of the cord and tumor was made by Dr. Stevenson. The pathologic process coordinates with the clinical course. While there were intervals after the trauma when symptoms were not present, subsequent developments showed that the lesion coincided closely with the site of injury. It appears that nerve tissue may be more prone to start tumor formation than other tissue.

The injury (fall from a horse) occurred in November, 1919, and was followed by only a transitory inconvenience a few days later, apparently due to muscular and joint injury, rather than damage to nerve elements. Twenty months later, the first pain appeared, evidently due to nerve change, was present for two months, disappeared for five months, and after that appeared with remissions, but no complete relief, until at nine months, evidence of cord compression appeared. Some months elapsed after the injury before the cells lost their normal restraints and took on malignant characteristics. On cord

section, Dr. Stevenson found evidence of central gliosis, but as no symptoms referable to this were evident, we are forced to conclude that the gliosis took place after the formation of the neuro-epithelioma (this is contrary to the conclusions of Schlaff).

The question whether earlier operation would have saved the patient is pertinent. She was under observation for months, but showed no symptom which was incompatible with an inflammatory lesion of the nerve roots. It was thought wise to defer operation until some clinical evidence of implication of the cord was obtained. A true diagnosis cannot be made until medullary symptoms appear. At no time would removal have been accomplished with less trauma or greater certainty of removing all potential tumor element. The future must determine the final value of radiotherapy, but our present knowledge holds out at least a hope that these tumors are susceptible of destruction by radioactive agents.

DISCUSSION

Dr. Foster Kennedy: The facts that Dr. Hartwell put forward are indisputable, and when I was confronted, on October 11, with clear evidence that we were dealing, not with hypertrophic cervical pachymeningitis, to which view I had, with a certain amount of obstinacy, adhered, I felt that I had made a blunder. Of course now, in the light of our after-knowledge, each symptom and sign appears definite, and one cannot go back to the standpoint one had before knowledge was complete. When the facts were once clear, we operated within a week. I am sure now that I should have advised Dr. Hartwell to operate when ptosis and small pupil occurred. Of course sympathetic paralysis might have resulted from hypertrophic pachymeningitis influencing the spinal roots. Had we operated we should have found a very small tumor playing the same rôle as inflammatory exudate, but I believe in any case the final result would have been the same.

Dr. E. G. Zabriskie: I would like to ask Dr. Hartwell, from the point of view of his experience, to take up the question of what possible influence an earlier operation would have had on the outcome of the case, whether it would have saved the patient and avoided the final event. In connection with the discussion, I would like to know what were the findings in the spinal fluid.

Dr. John A. Hartwell: In answer to the first question: I do not think earlier operation would have saved the patient. In view of the fact that the very small tumor removed from the pit in the anterior dura had recurred in seven weeks to a large size, the fact that at necropsy the whole neighboring dura and intervertebral foramina were infiltrated with tumor and the exceptionally malignant character of the tumor, as pointed out by Dr. Stevenson, I do not feel that operation would have been more successful if performed earlier. As to the information obtained by an earlier spinal puncture, I can only express the belief that none would have been forthcoming until pressure symptoms developed.

I would like to relieve Dr. Kennedy's mind as to why he was not able to arrive at a definite conclusion earlier. The patient was seen by several men who expressed the opinion that there might be a neoplasm, but no one of us could arrive at that conclusion. In view of this doubt, we hesitated to do an exploratory operation in the cervicodorsal region, which, as you will understand, is a procedure of considerable danger. As to what could have been accomplished by radiotherapy is a matter largely of conjecture. Undoubtedly, this type of tumor would be influenced by radio-active measures, but whether

it could be cured is quite another matter. After careful consideration it was decided that, in view of the doubtful diagnosis, operation offered more chance of relief than radiotherapy.

ON ASTEREOGNOSIS. DR. FOSTER KENNEDY.

Astereognosis (impaired ability to find the dimensional quality of the object) should not be confined to the cortex alone; it may be thalamic, peripheral, spinal or cerebral. I believe that this lack of function should be localized in clinical reports and that in examinations one should be careful to make sure what the subsidiary effects are in these cases. Astereognosis should be classified according to the physiologic or anatomic level of the sensory defect, and remarks should be qualified with the antecedent sensory losses when describing the condition.

DISCUSSION

DR. HENRY A. RILEY: Dr. Kennedy has given us an interesting presentation. I can recall Cushing's views expressed at the meeting of the American Neurological Association. To me the term astereognosis means the inability to recognize objects without the use of the eyes and in the presence of unaffected primary sensibility, which places it above the lower level and in the psychic areas of the cortex. As Dr. Kennedy pointed out, the faculty to recognize objects may be distorted by the abrogation of any of the constituent parts of sensation. I believe the term stereognosis gains greatly in value by limiting its application to the pure critical activity of the recognition of objects by the sense of feeling without the use of the eyes in the presence of unimpaired primary sense qualities, and that its loss, namely astereognosis, should be likewise restricted in its application.

DR. ABRAHAMSON: The phenomenon called astereognosis must first of all be differentiated from asymbolia; second, there are two reflex arcs, an upper and a lower, and in speaking of astereognosis, these have to be constantly kept in mind, especially when we wish to use this as a localizing sign.

Tonus orientation, being related to the cerebellum, it seems to me that occasionally when this sensation is severely affected, the recognition of objects by this sensation would suffer also. This did occur in estimating the sensation of weight, as the butchers do, by balancing the object in the air and estimating the weight by the amount of effort necessary to overcome gravity. The cerebellum is the reservoir of sensory impressions from the muscles, tendons, joints, etc., and its part in the genesis of astereognosis has to be considered.

DR. WECHSLER: Astereognosis is a specific psychologic concept. Clinically it consists of inability to recognize objects and, as Head has shown, of loss of the sense of position and discrimination. All other forms of sensation are intact. The seat of the lesion is either cortical or subcortical (postcentral) or limited to a small area of the thalamus. Now, if we are to use astereognosis generically and include under it any loss of ability to recognize objects, irrespective of the accompanying sensory disturbance, we shall simply discard a term which has definite clinical, anatomic and psychologic value. Obviously, one cannot recognize an object if one has no sense of touch or pain and temperature, but the failure is not due to any conceptual defect. And just as we limit the term aphasia to speech disturbance in the presence of intact peripheral speech apparatus, both on the receptive and the expressive side, so should we do with astereognosis. Unless, therefore, one denies a higher psychologic

concept to the term or merely wants to use it generically, and then qualify it so as to associate the other specific sensory losses in order to localize the seat of the lesion, it seems that the more restricted use of the term is to be preferred.

DR. E. D. FRIEDMAN: Dr. Kennedy has given us a lucid explanation of this phenomenon. Strumpfel has recently published an article on this subject. According to Wernicke, the local area in the brain is in the lower arc alone. He calls astereognosis the inability to recognize objects placed in the hand. According to Strumpfel, there is no astereognosis without disturbance of the posterior column. Occasionally from a focal lesion in the brain, postural sense can be lost. The question of aphasia is similar, whether we indicate a local area in the brain which leads to aphasia, or whether other parts are implicated and aphasia results. Astereognosis is not strictly a cortical phenomenon, but can arise from other portions of the brain. Polyneuritis is a columnar involvement and in combined sclerosis there is loss of power with typical athetosis. Astereognosis can occur in lesions of the thalamus. Déjerine and Lucie do not limit astereognosis to lesions of the cortex.

DR. FOSTER KENNEDY: Replying to Dr. Wechsler, it would seem as if he would limit the word astereognosis to purely cortical conditions. This is what Cushing did. He defined it as cortical, and he had in mind a purely diagrammatic idea that astereognosis was a cortical phenomenon and indicated the postrolandic area. Dr. Wechsler says astereognosis is a cortical function. I think this concept would increase error in this question. I believe these patients are always sensorially abnormal. You may have to move the finger in a wider angle to get the patient to recognize the object, or to use greater pressure; in other words, to give the patient more information in one way or another to find out whether he is kinesthetically accurate or not. You will find inability to recognize form only when other sensation defects exist.

Tuesday, April 1, 1924

E. G. ZABRISKIE, M.D., *President, in the Chair*

INJURY TO THE CERVICAL ROOTS AND CORD WITH CENTRAL PAIN. DR. GEORGE H. HYSLOP (by invitation).

A woman, aged 36, was injured in an automobile accident, Nov. 15, 1921. She was in a hospital for a week, and during this time had severe pain in the back of the neck, the right side of the neck and over the right shoulder. Movement of the right arm at the shoulder joint aggravated this pain. In addition, there was a sharp constant pain just below the right breast, extending from the midline in front to the midline posteriorly on the right side. She did not recall any bruising or swelling of the right side of the neck above the clavicle, but there were large bruises from the right shoulder down to the wrist. The pain in the right side of the chest gradually diminished, and was not troublesome fifteen months later.

Ever since the injury, attacks of pain had occurred several times a week without a discoverable exciting cause, such as fatigue, excitement or use of the right arm. The order of events in these spells was: (1) pain in the back of the upper part of the neck, a sensation of coldness and of "running water" across the right shoulder and pain down the right arm; (2) pain like

a toothache in the third and fourth fingers of the right hand and third and fourth toes of the right foot; (3) the third and fourth fingers of the right hand became white and cold; (4) weakness of the right hand so that any object being held in it was suddenly dropped.

During one attack I observed weakness of the hand and wrist muscles, most marked in the finger and wrist flexors. Station and gait were normal. There was no rigidity of the spine.

The strength of the right hand and arm was normal; there was no atrophy, tremor, ataxia or fibrillation. The tendon reflexes of the right arm were equal to those of the left arm although on some occasions the right biceps and supinator jerks seemed less active than those on the left. There was tenderness over the fourth, fifth, sixth and seventh cervical vertebrae and also over the fourth and fifth dorsal vertebrae. The objective sensory findings were confused by functional overflow phenomena which made it difficult to decide the exact type and extent of organic disturbances. The following abnormalities seemed fairly constant: (1) Slight diminution of all forms of sensibility—touch, pin-prick, temperature and vibratory sensibility—on the dorsum of the right hand, especially on the inner half and dorsum of the forearm about in the zone supplied by the sixth and seventh cervical segments. These were present when there was no pain. During an attack of pain the area of diminished sensibility was more extensive. There was hyperesthesia over the posterior part of the right shoulder and also roughly over the right trapezius muscle in the area supplied by the third and fourth cervical nerves. As soon as painful stimuli were applied in this area, a patch of "goose-flesh" appeared over the outer and posterior aspects of the right arm from the shoulder nearly to the elbow. This goose-flesh persisted as long as painful stimuli were continued, and faded out gradually in about five seconds after stimuli ceased; it was also observed to appear spontaneously once or twice. Blood pressure was equal in both arms.

Roentgen-ray examination by Dr. Lewis Gregory Cole revealed: (1) The bodies of the cervical vertebrae are normal in size, shape, and alinement, and the spacing between them is adequate. The second and third intervertebral foramina, which transmit the fourth and fifth nerve roots, are distinctly smaller than normal compared with those above and below. (2) The bodies of the dorsal and lower cervical vertebrae are normal in size, shape and alinement. The spacing between them is adequate. There is a slight curvature in the mid-dorsal region, and there is a slight tendency to a lipping and bridging between the vertebrae; this is observed in both anteroposterior and lateral directions, particularly laterally.

An accurate localization and description of the pathology in this case is difficult. From the objective standpoint, there are the following points of importance: (1) the goose-flesh phenomenon; (2) the temporary swelling of the right hand after a pain attack (this was observed by me on one occasion); (3) the coldness, pallor and weakness of the right third and fourth fingers during an attack of pain; (4) the constant tenderness in two areas of the spine.

In the history, the following points may be linked with the objective findings mentioned: (1) the occurrence of attacks during sleep causing the patient to awaken; (2) the order of appearance of symptoms during an attack; (3) involvement of the toes during an attack.

I do not believe that the findings or the history indicate that there has been an injury either to the brachial plexus or to the nerve trunks before they

combine to form the plexus. An injury to the plexus or nerve trunks sufficient to produce the present symptomatology would have caused, originally, a complete loss of sensation and also more or less paralysis in the areas supplied by the injured trunks. It should be noted that the patient did not complain of weakness of the arm immediately after the injury was received.

I am inclined to the opinion that during the accident the patient received direct or indirect trauma to the vertebral column and that the degree of violence was sufficient to produce a lesion in the central part of the spinal cord, which was not enough to destroy tissue but was sufficient to produce irritation symptoms. It is quite probable that there was also produced, at the same time, an injury to the meninges and posterior roots in the lower cervical segments. The spread of pain to the toes of the right foot would be a logical consequence of injury to the medullary portion of the spinal cord. It should be noted that the toe involvement is homolateral to the hand involvement. Gordon Holmes has stated that lesions of the dorsal columns may produce central pain. I believe that at the time this patient received her injury, there occurred petechial hemorrhages in the arachnoid and possibly in the dura and also in the posterior column on the right side. If the lesion were one about the central canal, or if it involved the spinothalamic pathway on the right side, one would expect the pain to be referred to the left foot. If the left spinothalamic pathway were involved, one would expect a different sort of sensory picture than was found in this patient.

The significance of the reduction in size, especially on the right side, of the second and third intervertebral foramina is open to question. It is through these foramina that the fourth and fifth cervical roots pass, and in the clinical examination there was evidence of involvement of these roots—the zone of hyperesthesia and the goose-flesh phenomenon. The vasomotor disturbances in the hand and the weakness of the flexor muscles of the wrist and fingers would be associated with a lesion involving the meninges and roots in the lower cervical region, and it is not necessary to postulate injury to the lower cervical nerves in the canals or in the neck. It should be noted that there have never been any objective vasomotor, sensory or motor abnormalities in the right foot.

Dr. Lewis Gregory Cole (by invitation) presented lantern slides illustrating the condition of narrowing of intervertebral foramina, with consequent compression of the nerve. Dr. Cole stated that considerable time and effort had been expended in perfecting a technic by which a roentgenogram of the foramina could be obtained; it had been impossible to get this view in the upright position and also in the prone position; finally by arranging an oblique view, it had been found possible to take a plate including the seventh or eighth cervical or first dorsal. In cases in which there was an almost classical list of symptoms—the patients complaining of pain in the shoulder, elbow and hand—it was found that there was no pathology in these joints, but almost invariably the condition was found to be in the vertebrae, in which a narrow foramen caused nerve compression. The case reported by Dr. Hyslop was rather exceptional and did not present the usual findings in these cases.

DISCUSSION

Dr. M. Keschner: Neurologists send patients to the roentgenologist believing that there is compression of the intervertebral foramina, but I am afraid that most of the roentgenologists have not mastered the beautiful technic shown by Dr. Cole.

DR. E. G. ZABRISKIE: I would like to recall to Dr. Cole some work done at the time of the opening of the Neurological Institute, when he presented the subject with earnest zeal, and we were unable to confirm his findings. Perhaps he did not have his technic so perfect as he has now. I remember some disappointing instances in which the symptoms were supposed to be due to compression, and which were subsequently found to be due to spinal cord tumors.

DR. I. ABRAHAMSON said: I should like to read the article of Dr. Gordon Holmes in full to study what other sensory phenomena were found in his case, such as might also indicate involvement of the posterior columns. In a case of gunshot wound in the neighborhood of, but not directly involving, the cord substance, a case in which operation showed the cord to be macroscopically intact, severe pains in the legs were present, though all signs pointed to a lesion at the fourth dorsal segment. I should like to ask Dr. Hyslop whether he recalled the existence in Dr. Holmes' case of disturbances pointing to involvement of the posterior columns.

DR. BYRON STOOKEY: It seems to me that if the foramina of exit of the cervical nerves are narrowed by minute and constant bony change, a constant change of symptoms and not intermittent symptoms is to be expected. In this patient, compression of the fourth and fifth roots has been predicated by reason of the narrow intervertebral foramina. It would be extremely difficult on this basis to explain the sensory findings presented when sensory changes are present in the forearm corresponding to the seventh cervical dermatome, and those of the arm and shoulder also include part of the sixth dermatome. Furthermore, the area outlined in the dorsal triangle of the neck does not correspond exactly with either the fourth or fifth or the combined area of both dermatomes. The hyperesthesia present in this area, strange to say, involves only the primary dorsal divisions of the fifth and sixth cervical nerves. If the fifth and sixth cervical nerves were compressed in the intervertebral foramina, it would seem likely that the hyperesthesia would involve not only the primary dorsal divisions but also the primary ventral divisions as well. Thus the sensory phenomena so accurately outlined and carefully studied by Dr. Hyslop do not correspond to the distribution of the nerves which make their exit through the fourth and fifth intervertebral foramina which Dr. Cole finds narrowed in the roentgenograms.

On the motor side, no atrophy and no weakness has been described corresponding to the muscular distribution of either the fourth, fifth or sixth cervical roots, with the single exception that the biceps reflex is at times altered. We know that the cervical roots which contribute to the brachial plexus are not all of equal size. It would seem probable, therefore, that we should find a normal variation and difference in the size of the intervertebral foramina through which they make their exit, the foramina being larger for the larger roots and smaller where the smaller roots are to be found.

In view of the vasomotor disturbances described by Dr. Hyslop in the fourth and fifth fingers and fourth and fifth toes, I would be rather more inclined to accept his view that the pathology is within the spinal cord. Certainly the changes found in the fourth and fifth toes cannot be accounted for by compression of the fourth and fifth cervical roots. It would be interesting to see this patient presented at a later time after she has been observed further.

DR. L. G. COLE: I am sorry this is not a classical case, roentgenographically speaking, of diminution of the intervertebral foramina. Compared with others which I showed you, there is not a marked diminution. I think there is a

moderate diminution. Regarding the interest of the roentgenologists, I think they are discouraged because it is a difficult position to get. We tried for a long time, first in the erect position, then in the prone, and finally found a position which we have used for the last ten months, in which we can show down to the seventh and eighth and perhaps the first dorsal. I think after a time roentgenologists will take up this work. They are slow getting at the different lesions.

Dr. Hyslop: This patient was refractory to treatment and it has been impossible to perform any pharmacologic experiments. Other physicians first made the diagnosis that the patient had received a plexus injury on the right side. When we observed that the toes were involved, it was obvious that there must be some involvement of the cord. Since we must postulate some pathologic condition in the cord, I think the primary focus is at the level of the fourth cervical root, and that there is a spread of impulses to the lower cervical segments. I do not understand the pain in the right toes. It is homolateral, and it is real. It is purely pain and nothing else—that is, there are no objective vasomotor disturbances. Dr. Cole found these particular foramina involved without having read the clinical history of the case. If that is a coincidence, it is interesting. There may have been a causal relationship. I do not think it is necessary to have constant objective findings. There may be periodic neuralgia in association with lesions of the intervertebral part of the roots and also with traumatic lesions of the meninges, yet there may be in such cases intervals in which there are no symptoms. We may have in this case contusion of the roots and also contusion of the cord and meninges. There may be slight glial proliferation near the central canal and in the medulla.

Gordon Holmes observed hyperesthesia to the tuning fork in the cases with pain which he attributed to a lesion in the posterior columns.

Presentation of Cases of Paresis Exhibiting Some Results Obtained by Treatment with Tryparsamide and Treatment with Malaria. Dr. George H. Kirby and Dr. Henry A. Bunker, Jr.

Six patients were presented, four having been treated with tryparsamide and two by inoculation with malaria. All had presented clinical symptoms and serologic findings which left no doubt as to the diagnosis of paresis. The cases were selected from among a large number which, during the past nine months, have been treated in the clinical service of the Psychiatric Institute at the Manhattan State Hospital. In all six cases a good remission has been attained in the sense that the psychotic symptoms have subsided, insight has been acquired, the general physical condition has improved, and the serologic findings have been favorably influenced.

A brief synopsis of the four cases in which the patients were treated by tryparsamide follows:

Case 1.—A woman, aged 38, had an illness which began ten months before admission to the hospital, with indifference, forgetfulness and later grandiose ideas. Her pupils were sluggish to light; her knee jerks were increased; tremors were present. The Wassermann reaction in the blood was ++++; the spinal fluid ++++ in all dilutions, globulin +++, 20 cells. After three courses of treatment, the patient had gained 40 pounds (18 kg.), the grandiose ideas had disappeared, and she had good insight. The physical signs remained unchanged. The Wassermann reaction in the blood was negative, the spinal fluid positive in 1 c.c.; the colloidal gold curve still approximated the paretic

type. The patient left the hospital after eight months' residence, and recently secured a position.

CASE 2.—A man, aged 45, had an illness which began about a year before admission, with change in disposition and later euphoria, memory defect, reckless driving of automobile and grandiose ideas. He had Argyll Robertson pupils, exaggerated knee jerks, tremors and speech defect. The Wassermann reaction in the blood was ++++; the spinal fluid ++++ in all dilutions, globulin +++, 5 cells, and there was a typical paretic gold curve. Under treatment he gained in weight, and left the hospital after eight months. His grandiose ideas disappeared, memory improved, and insight was attained. The physical signs remained unchanged except that the speech defect was less noticeable. The Wassermann reaction in the blood was negative; the spinal fluid was negative in all dilutions; the globulin test was +; there was 1 cell; the gold curve still preserved a paretic character.

CASE 3.—A man, aged 30, had an illness which began six months before admission, with change in mood, neglect of work, forgetfulness, and finally excitement, with expansive ideas. The Wassermann reaction in the blood was ++++; the spinal fluid ++++ in all dilutions, globulin ++, 35 cells, and there was a paretic gold curve. There were: sluggish pupils, increased knee jerks and tremors. Under treatment, the patient gained 33 pounds (15 kg.) and went home in six months, and resumed work. He had good insight. The Wassermann reaction in the blood is now negative; the spinal fluid is still positive, but less strongly so. The globulin test is +; the colloidal gold curve is no longer paretic in character.

CASE 4.—A woman, aged 36, had an illness which began about three years before admission, with irritability, forgetfulness and finally a paranoid trend. Tremor and speech defect were early symptoms. The Wassermann reaction in the blood was ++++, the spinal fluid ++++ in all dilutions, globulin +++, 26 cells. There were Argyll Robertson pupils, increased knee jerks, tremors and speech defect. The patient improved under treatment, gained 30 pounds (13 kg.), the psychotic symptoms disappeared, and insight was acquired. She is now ready to go home. She still shows some evidence of emotional instability, and memory is not as good as it formerly was. The Wassermann reaction in the blood remains positive, +++; the spinal fluid is positive only with 1 c.c., globulin +, cells, colloidal gold curve paretic in type. The physical signs are unchanged.

Two cases which have been treated by inoculation with malaria were demonstrated.

CASE 5.—A man, aged 29, had an illness which began three months before admission, with forgetfulness and inattention to work, apathy and drowsiness. Later he was euphoric and overactive, with numerous grandiose ideas. The pupils were unequal and irregular, but reacted well. The Wassermann test in the blood was ++++, spinal fluid ++++ in all dilutions, globulin ++, 99 cells, gold curve strongly paretic. The patient was inoculated with malaria and allowed to have ten paroxysms. The temperature ranged from 104.2 to 106 F. Improvement was noted two weeks after completion of treatment. He gained insight, the grandiose ideas disappeared, memory was unimpaired except for a period of three months preceding his improvement. Final serology showed the blood Wassermann test negative, the spinal fluid Wassermann test positive with 1 c.c. of spinal fluid, globulin ±, 12 cells, and a gold

curve 3333321000. The physical signs were unchanged. The total gain in weight since completion of treatment was 10 pounds (4 kg.).

CASE 6.—A man, aged 30, a year before admission had a transient episode of excitement. For five months before admission, he made indefinite complaints of indigestion. Two weeks before admission, he became excited and exalted. This excitement was marked at the time of his admission. His pupils were slightly unequal, the reaction diminished. The tendon reflexes were active. The Wassermann test in the blood was ++++, spinal fluid ++++ in all dilutions, globulin ++, 11 cells, the gold curve of the paretic type. He was inoculated with malaria. He had seven paroxysms, the temperature ranging from 103.8 to 105.8 F. Within a week after completion of treatment, the symptoms began to subside, and improvement progressed to a good remission. He had insight, but only a fragmentary recollection of the first five weeks of the period in the hospital. The final serology showed a negative Wassermann test, spinal fluid ++ with 1 c.c., globulin negative, 3 cells, gold curve 001221½000. The physical signs were unchanged. The total gain in weight since completion of malarial treatment was 40 pounds (18 kg.).

DISCUSSION

DR. M. KESCHNER: I should like to ask about an episode in one of the patients.

DR. BUNKER: The man had incurred financial obligations and was in an excited condition. His superior in the company said he had to cut down his work. He took a short rest. He identifies his present attack with that other upset, and does not consider it more serious. That is the only point in which his insight is faulty. We have no definite history of syphilis in this case. At the age of 16 he had gonorrhea. That was his only extramarital exposure. He may have contracted syphilis at that time.

DR. H. A. RILEY: I would like to know what the spinal fluid Wassermann reactions show in cases which indicate spontaneous remissions.

DR. MCKENDREE: Have you other cases in this series which show early signs, and which have not yielded to treatment as well as these cases presented?

DR. I. ABRAHAMSON: Has Dr. Kirby seen any bad eye complications in any cases reported? What about the comparison of the colloidal gold curve in the two methods? In the malaria method, the patients show marked improvement in the colloidal gold curve. The cases Dr. Kirby presented did not show this.

DR. OBERNDORF: These persons were all young, healthy people. Have older and less promising cases been tried, and if so, with what results?

DR. PARDEE: Were any patients treated in the prepsychotic stage? All these patients have had a definite psychosis. Has the treatment been started in persons in an early stage to ward off the psychosis?

DR. CHANEY: In a patient with general paralysis of ten years' duration who had received 100 doses of arsphenamin, the improvement has been marvelous. The patient has gained 20 pounds (9 kg.) after three treatments. The Wassermann reaction is still positive. I tried the treatment in a patient who had lightning pains. It had no effect on the pains. In one case of spastic paraplegia, there was no effect, and in six cases the treatment had no effect on the Wassermann reaction.

DR. KESCHNER: In one patient, there were signs of general paralysis a year ago. Perhaps that was a spontaneous remission between that and the present time.

DR. ZABRISKIE: It is interesting to contrast these cases with cases of congenital syphilis. These may go on unsuspected for ten or twenty years. Then the patients break down and show syphilitic signs under split protein reactions or ordinary infections.

DR. KIRBY: We did not select these cases particularly, except that the patients appear to have made good remissions. A number of patients in the hospital have not done so well. Some do not respond to either method of treatment. One of these had a duration of three years, one of one year, before treatment. The onset of symptoms was not rapid. The question in regard to the serologic picture in cases of spontaneous remission is interesting. We have not many data to offer, but in some untreated patients with spontaneous remission there was mental improvement without serologic improvement. The colloidal gold curve is the one most resistant to treatment. In one tryparsamide case, the curve is normal. In the other three, the curve is still paralytic. We have seen complete reduction of the Wassermann reaction and flattening out of the colloidal gold curve in patients who did not improve mentally. In regard to treatment of the prepsychotic stage, I have had no experience. In some paralytic patients there is increased cell count without mental symptoms. Probably the serology is set before mental symptoms appear.

DR. BUNKER: It is possible that the man had a former attack of general paralysis, before the present one, and may have had a remission, but so far as we can determine, the disease dates from the beginning of this last attack. Grandiose ideas seem rather a part of his personality, and his symptoms would take that form. As to the influence of the two methods of treatment on the colloidal gold reaction, the number of cases is limited. We should try cases with the three curves and compare them with the malarial treatment. Speaking tentatively, the malarial treatment has a greater effect, seemingly, on the colloidal gold and other reactions.

DR. I. ABRAHAMSON: Do you remember Weigand's results?

DR. BUNKER: The Germans do not lay much stress on the serologic results. Usually they run parallel with the clinical signs.

A CASE OF MALIGNANT SPHENO-OCCIPITAL CHORDOMA. DR. JOHN L. ECKEL, Buffalo.

A man, aged 49, was admitted to the City Hospital, Aug. 28, 1923, and died Nov. 12, 1923. His previous history was unimportant. His present illness began in the autumn of 1921, with headache, dizziness, throbbing in the head and pain in the cervical portion of the spine. Examination at that time revealed numerous bad teeth and some blurring of vision in the left eye. After removal of the teeth, vision cleared.

In August, 1923, when admitted to the hospital by ambulance, he complained of inability to walk and of little power in any of the extremities. He said that tingling and numbness, beginning in the fingers and later spreading over the arms and body, had begun eight months before. In the lower extremities, it had begun in the feet, working up. At no time was there vomiting or dysphagia. There was no double vision, no choking of disks.

On admission, smell and taste, hearing and sight were normal; sensation over the fifth nerve was normal. There was weakness of the lower facial muscles on both sides, and distinct atrophy, with fibrillary tremor of the tongue on both sides. There was little power in the extremities. The hands showed loss of pain, temperature and position sense, which extended up the arm to the elbow, but above the elbow pain and cold could be distinguished in spots. The same condition was true of the lower extremities, loss of pain, temperature, position and vibration being nearly complete to the knees and less so to the hips. Sensation was not entirely lost over the trunk. He showed indefinite extensor toe signs in the left foot. He had to be catheterized and had to be fed. His pulse rate was 96. His blood pressure was: systolic, 114; diastolic, 70. His temperature was normal. Hemoglobin content was 80 per cent., red blood cells numbered 4,120,000 and the white cells 6,800. The Wassermann reaction was negative in the blood and spinal fluid.

The roentgenogram showed a slight shadow at the base, which extended about the foramen magnum and apparently through it for some distance, so that a probable diagnosis of a tumor at the base of the brain was made.

While in the hospital, the symptoms progressed to total paralysis of all extremities, and all forms of sensation were practically lost to the upper cervical region for three weeks prior to his death. However, he remained clear mentally. He died of lobar pneumonia, Nov. 12, 1923.

Pathologic Report (by Dr. W. F. Jacobs of Buffalo).—Necropsy showed a brain in which the convolutions were compressed, and at the base a rather flat tumor attached along the pons, medulla and left hemisphere of the cerebellum. The brain was removed from it with some difficulty. The tumor itself extended into the bone forming the base of the skull and also for some distance through the foramen magnum to the second cervical vertebra. It was smooth, glistening, encapsulated, lobulated. It measured 5 cm. anteroposteriorly, 3.5 cm. laterally, and was 3 cm. thick on an average. Histologically, the tumor proved to be a malignant chordoma. This type of tumor arises from the remains of the chorda dorsalis, a portion persisting at the junction of the spheno-occipital bone. The same type of tumor is occasionally found at the sacrococcygeal junction. In the center of the intervertebral disks, it remains as the nucleus pulposus, and occasionally an overgrowth of this produces a tumor mass extending from the side of the vertebral bodies.

DISCUSSION

DR. I. ABRAHAMSON: With a tumor situated as in the present case, the preservation of the vibratory and the deep sensibility was unusual; they are affected early and more intensely than other forms of sensation. A complete quadriplegia is suggestive of a lesion compressing the cord at or about the region of the foramen magnum. The early occurrence of the spinal or radicular type of astereognosis bears out the observations of others in high cervical tumors. In one of my cases of quadriplegia, there was a neuroma of the suboccipital nerve roots which invaded the foramen magnum and caused extramedullary cord compression at the level of the second and third cervical segments.

DR. ECKEL: In reply I would state that loss of sensation began in the hands and later in the feet, and gradually extended up the limbs to the shoulders and hips, respectively.

BOSTON SOCIETY OF PSYCHIATRY AND NEUROLOGY

Regular Meeting, March 20, 1924

DONALD GREGG, M.D., *Secretary, in the Chair*

PHYSIOLOGIC TYPES OF DISABILITY FOLLOWING BIRTH INJURY. DR. BRONSON CROTHERS.

The central nervous system of the fetus may be injured in any part during child-birth. Certain of these lesions involve the death of the baby through damage to the respiratory centers of the medulla and upper cord. On the other hand, it is clear that, on physiologic grounds, lesions below the phrenic nuclei or above the tentorium are consistent with life and that varying syndromes may be expected.

Two important series of observations from pathologic laboratories are to be considered. First, it has been established beyond question that the majority of hemorrhages within the cranial cavity are due to the effect of pressure. This may act in either of two ways. The stress of delivery may distort the head, and this distortion combined with uneven intracranial pressure may cause a rupture of the tentorium at its junction with the falx. Such an injury may involve the vein of Galen or its tributaries. The series of reports starting with Beneke's paper in 1910 presents this aspect of the question in conclusive fashion. Another mechanism by which pressure may cause cerebral injury is emphasized by Schwartz. He points out that the caput succedaneum is only one manifestation of edema which involves the meninges and the brain itself. The second series of observations is concerned with injuries of the spinal cord. The figures of Pierson, who shows that the cervical spinal column was ruptured in 38 per cent. of the babies who died during or after breech extraction at Sloane Hospital, are enough to establish the possibility of cord injury.

The clinical importance of these observations is evident. The prognosis is clearly different, depending on whether the cord is transected, or the midbrain injured, or the basal ganglia damaged, or the cortex involved. Cases were presented to show: (1) complete destruction of the lower thoracic and lumbar cord; (2) transection, essentially complete, with reflexes maintained; (3) injuries logically localized in the midbrain with squint and nystagmus as presenting signs; (4) double athetosis presumably due to involvement of the basal ganglia; (5) idiocy with spasticity which was attributed to cortical and pyramidal tract damage.

The groups which can be easily separated are: (1) pyramidal, (2) extrapyramidal and (3) spinal. Of the three, only the first is likely to be followed by epilepsy and feeble-mindedness. The other two lead to purely motor abnormalities. These groups are distinguishable by observation of physiologic disturbances rather than by collection and study of a series of observations on conventional reflexes.

DISCUSSION

DR. R. L. DENORMANDIE: Some of us must be doing poor work. I wish every obstetrician could see these patients. I should like to know who delivered these children in order to learn how it was done and how such results may be

avoided. In my private work, I have seen no such cases. I do not see how one can obviate hard deliveries.

Dr. Bronson Crothers: Theoretically, injuries of the brachial plexus and the spinal cord should never happen. In using force in delivering a child there is danger of spoiling the brachial plexus, and in wrecking the brachial plexus there is a big chance of hurting the spinal cord. Most of the obstetricians do not realize that there are two kinds of force; one is physiologic, and the other—traction—is unphysiologic. It seems to me they use the two motions interchangeably. If the shoulders are not coming through, they should push them out rather than draw on the head.

Dr. Gilbert Horrax: Do you see much improvement from year to year in the level of anesthesia?

Dr. Crothers: Yes, there is improvement from year to year.

Dr. Horrax: What do you do for these cord cases?

Dr. Crothers: About all we can do is to prevent infection and keep the bladders clean and prevent contraction. When the injury is subcortical, education is tremendously important.

A Physician: Most of the deliveries at the Lying-In Hospital are normal.

Dr. Crothers: You probably mean there are few physiologic injuries. You cannot have a surgical injury without danger of a malpractice suit. I am not sure you can prove there has been a cord injury.

Dr. Douglas A. Thom: How long after delivery can evidence of these injuries be made?

Dr. Crothers: If the parents say the baby is normal up to nine months, you can practically exclude birth injury. There is always a chance of unrecognized encephalitis. I think in that mistakes are made one way as well as the other. We do not lay enough stress on intercurrent infections, and other conditions. None of the children shown at this meeting have ever been normal. Most of them had convulsions after the first few days, which I think is reasonable evidence of birth injury.

End Results of Operations for Spina Bifida. Dr. George David Cutler.

This article will appear in full in a later issue of the Archives.

Acid Base Metabolism in Epilepsy. Dr. James L. Gamble (by invitation)

This was a preliminary report and is not yet ready for publication.

Psychiatric Studies of Young Children. Dr. Douglas A. Thom.

The clinics for children of the preschool age were organized in November, 1922, with the idea of determining what the psychiatrists had to contribute to the Community Health Clinics primarily interested in the physical welfare of children. Habit clinics became part of a well-organized medical group in the community and were developed throughout several sections of the city in order that they might render their service to the community in the most convenient manner. The closest cooperation was established between the various social agencies already in existence, such as the community Health Association, Family Welfare Society, child-placing agencies, Children's Aid, Children's

Hospital, the nursery schools, kindergartens and community centers. The clinics were further considered therapeutic centers and not research laboratories.

The problems presented at the clinic divide themselves rather roughly into two groups—those of undesirable habits and those of personality defects. (Numerous cases in each group were cited.)

The habit clinic idea has developed during the past two years in and about Boston in a satisfactory manner. The Community Health Association has accepted the mental clinics as part of its routine work. The Division of Mental Hygiene has also incorporated the habit clinics into its program of preventive medicine and the city of Boston has a clinic for children of the preschool age at their health center. There seems but little doubt that the value of such clinics has been established and that the rapidity of their development will depend only on funds and personnel.

DISCUSSION

DR. DONALD GREGG: I think we hardly realize what an interest the community in general takes in these problems. It was brought to our attention a week or two ago, when in response to a reference made in a daily paper to Dr. Thom's paper on "Fussy Food Habits," we received 150 requests for a copy. Requests came even from Alaska and from Cuba, which shows the great interest mothers are taking in regard to the habits of their children.

A PHYSICIAN: It would be desirable to have the leaflets Dr. Thom has prepared published in a series.

DR. DONALD GREGG: What results are you getting? Or are you not far enough along in the work to have reached any conclusions?

DR. DOUGLAS A. THOM: In the cases we are dealing with of habits in the home, it is so purely individual that we feel anything done is satisfactory. We are able to formulate our results on those particular subjects in such a way that we can hand them over to the nurses and mothers themselves while we go on to the more complicated problems of personality.

CHICAGO NEUROLOGICAL SOCIETY

Regular Meeting, April 17, 1924

JULIUS GRINKER, M.D., *President, in the Chair*

COMPARATIVE METHOD IN PSYCHIATRY. DR. WILLIAM A. WHITE, Washington, D. C. (by invitation).

If we define the material with which psychology deals we can only say that everything is properly the subject of psychology that deals with the reactions of the organism as a whole. So long as we deal with any particular part of the organism, or with the function of any particular organ or system of organs we are dealing in a theory that is essentially physiologic, but the moment we answer or attempt to answer the questions "What is the organism doing?" or "What is the man doing?" we are immediately projected into the field of psychology and can only answer that question by psychology.

Euclid said that parallel lines never meet. The newer mathematicians say it is not necessary to stick to the postulates of Euclid, that we can make our own, and if we wish we can start with the postulate that parallel lines do meet. Starting with that postulate, geometry is very different, and the things that follow are very different from the conclusions of Euclid. Starting with this postulate of mine, the moment we start to answer the question "What is the organism doing?" the moment we start to speak of the organism as a whole, we have a certain postulate, and as a result of logical fate we have certain deductions which we cannot escape.

One of these deductions I think is of enormous importance—that the mind is as old as the body, that the history of the man is as old as the history of the body. If that is accepted as true, as it seems to me it must be, then we are in a position where we must necessarily realize that we never can know very much about any organism until we have learned to study the history of how that organism became what it is. It is on the historical aspect of the organism that the comparative method rests.

The nervous system is the modifier and the integrator of the various parts of the organism, and it is natural that in this great central integrator and coordinator we should look for the solution of the problems of the psyche. For years attempts have been made to study and unravel the mysteries of mental disease by looking through the microscope at the cortex and by study of the individual, leaving out the comparative method. I thought thirty years ago that the comparative method was the proper one for the study of mental disease and the different ways in which it manifested itself in different races of people; and I felt that when Prof. Kräpelin made certain observations in the Island of Java that he was making a real contribution to comparative psychology. That is true only in a certain limited sense, for after all it only scratches the surface of things. We are prone to forget that man, as man, has been living on this earth for easily 500,000 years or perhaps a million years, and that our historical records only reach back a little 1 per cent. of that distance; that no races now inhabiting the earth are primitive in any sense of the word. The most savage individuals we know are highly developed, of high culture, with an intricate social organization which is so complex that it takes years to unravel.

It is not necessary to study mental disease in savage man. We have another method at hand, which we are sometimes inclined to overlook, and that is the law which Haeckel laid down a generation or so ago—every individual in his individual development recapitulates the developmental history of the race. We are coming to learn, I think, that the development of man as it goes through the various stages also recapitulates roughly and rapidly the history of the race. It is exceedingly rapid, for we are almost ready to die when we are born; 98 per cent. of our development antedates our birth. A million years at least, probably a hundred million years, are condensed into nine months of intra-uterine life, and it is difficult to progress much beyond that in the thirty, forty or sixty years that remain.

If we unravel the history of our psychotic patients, we will find there a rich material for the comparative method. It is perhaps to the credit of the psychanalytic school that it has emphasized the study of the historical antecedents of mental states, and for the emphasis also that mental conditions are determined by laws that are just as rigid in their working out as are the laws in any other domain of natural science.

There has been developed in neurology in recent years, for the first time, a really careful, analytic study and a beginning understanding of motor phenomena, and we have come to a much larger concept of motor phenomena. Wilson's disease was one of the particular clinical pictures that threw light on the extrapyramidal motor phenomena. We have developed as the result of laboratory studies a whole system of phenomena, which Pollock and Davis have been working with, particularly the phenomena of decerebrate rigidity, whereby in the laboratory we make a section at certain parts of the motor system and release the more archaic components of the nervous system.

We have certain suggestions in the disease called epilepsy which make us believe that we are dealing there not with cortical imbalance but with cortical control and inhibition, with the release of functional and more archaic periods, so that the archaic functions, as it were, by itself, no longer in conjunction with and under the control of the higher, more specifically the cortical, inhibitory center. The same kind of concept is growing up in psychiatry, particularly in cases of dementia praecox. We believe that we are dealing here with a psychosis, the symptoms of which are largely produced by the functional ablation of the higher or psychologic components that determine conduct, with the consequent release of the older and the more archaic elements. We believe that we can analyze some of the symptoms of dementia praecox sufficiently to determine at least that not only individual components but also archaic components enter into its symptomatology. The same thing is taking place in the field of endocrinology.

One cannot work in science without hypotheses, but one must be prepared to give them up if they prove wrong. We have used the old methods; we have searched the cortex and have not found the etiology. Let us use the comparative method and try to find it there. I have been thinking about this theory of the organism as a whole for some years, and recently at St. Elizabeth's Hospital we have established an extraneural pathology of nervous disease. If we have persons who are defective at the psychologic level, if their minds show these regressive tendencies, if they have failed to develop up to the level that makes them perfect members of society, is it not fair to suppose that they did not have anything to build on, that they could not go further? In the extraneural pathology we find a definite pathology connected with the circulatory system, the thymus, and particularly the suprarenals. In patients with malignant dementia praecox we find the hearts one-third smaller than normal. The aorta is dependent on the size of the heart; all the rest of the vessels in the body and the vessels that go to the brain are therefore one-third smaller. Many persons have reached the limit of their development at 20. They have not the organic background to go further. It is perfectly natural that they may break down, and yet that one may find no reason for it in the brain. The nervous system cannot integrate anything that is not there.

This comparative method will give us information on the history of the organic make-up of the final picture. The personality make-up is a part of that problem, and I predict that the next great step in psychiatry will be taken when there is a conscious acceptance of the comparative method, without which it is impossible to pursue further the study of mental disease.

AMNESIA AND PATHOLOGIC STEALING. DR. RALPH HAMILL.

This case reveals two interesting mechanisms: avoidance of responsibility by amnesia and antisocial conduct determined by an emotional attitude acquired in youth. The patient, aged 32, always did well in school both in games and

in studies. Following graduation from high school, he taught in a country school and had illicit relations with the daughter of the farmer with whom he roomed. At 18, he married, but quarreled with his wife within a year. He changed jobs frequently. He discovered that his wife was unfaithful, and left her. He then enlisted in the army where he did well, rising to the rank of sergeant, first class, in five years. He was then sent to an officer's training camp and eventually received a commission. He remarried, and, after serving for two years, resigned from the army. Soon after this, in 1920, he secured a position as secretary to a chamber of commerce, and was made justice of the peace. He soon began to spend money belonging to the county. This shortage he knew would be discovered, as the accounts were checked up once a year by the county attorney, a man he disliked, and whom he thought resembled his father. This resemblance may have had something to do with the stealing, since, in handling the funds, $30,000, at the Chamber of Commerce, he had no supervision, no check up; if it had been merely the desire for money, he would have stolen from these funds. When he found himself $1,000 short, he confessed to the county attorney and borrowed the money to make restitution. He then went to work for a carpenter, but soon changed and became a printer. In October, 1921, he suddenly left home on a fugue and came to himself two days later in a hospital 250 miles from home, with complete amnesia not only for the two days but also for the two years since leaving the army. The latter memories, however, were soon recovered with assistance, and he returned home. He went to work as a clerk but again took money ($200) from his employer. Again he left on a fugue and came to himself four days later in El Paso. He returned home, arranged for his wife (from whom he is now divorced) to return to her folks, and he himself went back to his father's home.

A study of a series of dreams restored the memories for the events during the two fugues and also brought to light certain elements that offer an explanation for the reactions. From early boyhood, he had had an intense antagonism toward his father, who was very strict and endeavored to control all his activities. When the boy was 12, he and his mother contracted typhoid fever, and the mother died. From a small legacy of $700, the father deducted $200 to pay for expenses incurred during the illness. This aroused an intense feeling of resentment, which was, however, repressed. To this was added a feeling that if better care had been provided, the mother might not have died, and the patient attributed his mother's death and much suffering during a hard life to his father's lack of consideration.

The patient's matrimonial ventures had both proved unsatisfying, and he had found himself in need of money. He recalled that at the time of his appointment as justice of the peace, he had read to his wife a story of a man who had stolen thousands of dollars from his employer in repeated small thefts and had then fled to Mexico. He remembered that both he and his wife had expressed sympathy for the wife of the embezzler. In his second fugue, the patient had gone toward Mexico, although he had been prevented from entering that country by conditions that then obtained. It is also probably no accident that the amount taken at this time was $200, the sum taken from him by his father. The resentment toward the father had been transferred in a general way to any one in authority over him. The dreams also brought back memories of a high school teacher who had committed suicide over difficulties with his wife.

Book Reviews

SOCIAL CONTROL OF THE FEEBLEMINDED. A STUDY OF SOCIAL PROGRAMS AND ATTITUDES IN RELATION TO THE PROBLEMS OF MENTAL DEFICIENCY. By STANLEY P. DAVIES, Ph.D. Publication of the National Committee for Mental Hygiene, Inc., New York City. Paper. Pp. 222. Price, $1.25.

This is a well written thesis, outlining the various stages in the development of methods for control of the feebleminded, primarily from the point of view of the sociologist. In the first chapter, there is a brief historical retrospect of the following periods: 1. The ancient and medieval period. 2. The period of physiologic education starting in the early nineteenth century and ending with the establishment of the first custodial institution for the feebleminded. 3. The alarmist period, dating from about 1900 to 1915, based on studies in eugenics and the application of intelligence tests. 4. The modern period with extra-institutional methods of care, training and supervision.

Chapter 2 contains an interesting account of the work of Itard and Seguin, which culminated in the development of the physiologic method of education and the erroneous notion that all idiots could be developed into normal persons by proper sensory training. The author informs us that the various institutions for the feebleminded were established on the belief, due largely to Seguin, that in time there would be a complete solution of the problem of the mental defective through training. The institutions were, therefore, to be merely temporary devices as part of an educational program. They were retained (after the bubble burst) for the purpose of custodial care and in their first stages were limited to only the low grade cases.

In Chapters 3, 4 and 5 are reviewed, the various hereditary studies and the development of the Binet-Simon intelligence tests. As a result, an alarmist wave spread over the country in which, for a while, no other problem received more public concern than that of the feebleminded. "For purging from the blood of the race the innately defective strains" ten methods were considered by the investigation committee, appointed by the Research Committees of the Eugenics Section of the American Breeders' Association, May, 1911. Of these methods, only life segregation and sterilization were considered feasible. Eugenical sterilization laws were adopted by fifteen states. The operation of these laws was practically a fiasco, having no public sentiment behind it. According to Laughlin's figures, the total number of operations in the entire fifteen states, from 1917 to 1921, was 3,233, most of these being on the insane.

Among the newer aspects of heredity and behavior, Chapter 6, are considered the selective problems among the feebleminded and the findings, especially by Fernald and other investigators, that many of the so-called feebleminded are capable of maintaining themselves successfully in the community.

On page 79, the author states, on the basis of Potter's work, "One other indication resulting from Dr. Potter's investigations, which he would wish to confirm further before suggesting it in more than a tentative way, is that the majority of the hereditary type of mental defectives are of the imbecile and low-grade moron level of intelligence and that for the most part the higher grade morons and borderline defectives are of the nonhereditary type. If this on further inquiry proves to be the case, it would be an added reason for

retaining in the community, so far as possible, mental defectives of the higher intelligence levels inasmuch as there would not be great danger of passing on even this comparatively small degree of defect to the offspring."

This is a serious error and entirely reversed by Potter's investigations. The fact is that the higher grade defectives present the main difficulty, having inherited amentia, whereas the deficiency in the case of idiots and imbeciles is so gross as to comprise but a small percentage of the feebleminded in general and in an evolutionary sense almost self-eliminative.

The rest of the book is largely taken up with the newer developments in extra-institutional care at Waverley and at Rome. The colony plan as developed by Dr. Charles Bernstein, Superintendent of the Rome State School for Mental Defectives, Rome, New York, is handled with special thoroughness.

There are chapters on the public school and the backward child, the socializing process and some theoretical considerations relative to the Army mental tests. The author concludes: "The majority of the feebleminded may be safely and profitably retained as functioning members of society, both from an economical and a social standpoint, provided the group exercises over them a sufficient degree of social self-control to give them, until they approach adult life, the training suited to their capacities, and continues to furnish throughout their lives the sort of leadership which will foster in them the highest social ideals."

BIOLOGY OF THE INTERNAL SECRETIONS. THE ENDOCRINE FACTOR IN DEVELOPMENT, IN SUBNORMALITIES, IN NEOPLASMS AND MALIGNANCY, IN NERVOUS AND MENTAL DISEASES AND IN HEREDITY. By FRANCIS X. DERCUM, M.D., Ph.D., Professor of Nervous and Mental Diseases in the Jefferson Medical College. Cloth. Price, $2.75. Pp. 241. Philadelphia: W. B. Saunders, Company, 1924.

Contributions to our knowledge of the action of the glands of internal secretion may take the form of the discovery of new facts or the intelligent correlation and interpretation of facts concerning them. It is the latter aspect that Professor Dercum has chosen especially to present in his volume under the foregoing title, which he modestly refers to as an "essay."

Not only has the author brought together the known facts of endocrinology in a most attractive way, but he has presented them in broad outline so as to show their conformity to general biologic principles. For this purpose he has drawn on the storehouses of embryology, zoology, chemistry, anatomy, physiology, pathology, neurology, surgery and internal medicine, psychiatry and, in fact, all phases of biology in its broadest sense that can throw any light on a subject so much of which still remains shrouded in obscurity.

In a style that cannot but hold the readers' attention throughout the volume, the author marshals the physiologic results of the presence of normal and of abnormal endocrine glands, demonstrates the interdependence of these glands and their relation to the nervous system, and then proceeds to show the importance of the changes brought about by glandular dysfunction in their biologic conception.

The material on which the book is based is drawn from the clinic, and laboratory investigations have not been relied on, as has been true in so many other works on this subject. Until we have more experimental confirmation than has yet been afforded of the conclusions drawn solely from clinical

material in this as yet vague field, some will hesitate to believe that the study of the endocrine glands furnishes the key to the mysteries of some of the phenomena of life that are discussed in this book.

The amount of ground covered by Professor Dercum in this essay is so great that a reviewer can refer only to some salient points. Dogmatism finds no place in this book, but it is exceedingly rich in suggestiveness.

The author first depicts the normal person and the person in whom there are defects and deviations from normal, especially those with a reduction in the intensiveness of the physical and chemical processes. In the latter are found the stigmas of an inferior constitution, manifested in great part by variation from normal in some of the endocrine glands. Special emphasis is placed on the subject of status thymicolymphaticus as one in whom there is a general biologic feebleness of development.

The thyroid, the chromaffin system and the pituitary are grouped as innervated by the sympathetic system proper, all being among themselves synergically related and standing antagonistic to those glands innervated by the autonomic nervous system, namely, the pancreas, the thymus and the parathyroids.

There is also suggestive discussion on the relations of endocrinology to malignancy, heredity, the vitamins and numerous neuropathic conditions.

Whether or not one agrees with the inferences of the author as to the importance of the endocrine glands to all of the subjects on which he has opened discussion, one cannot but derive benefit from a consideration of the suggestions offered, and agree with the idea of the existence of broad biologic principles which underlie all of these phenomena, some of which directly concern the glands of internal secretion.

NEUROLOGIC DIAGNOSIS. By LOYAL EDWARD DAVIS, Philadelphia: W. B. Saunders Company, 1923, pp. 173.

In his preface, Dr. Davis says: "If this book serves as a bridge between the text-book upon the anatomy of the nervous system and the clinical text of nervous diseases it will fulfil its purpose." The need of such a bridge, which is short enough to be easily crossed by the busy student, has been appreciated only in recent years, and Davis has met this need perhaps better than any who have so far tried to fill it.

Approximately the first third of the book consists of general principles of neurologic diagnosis, covering the essentials of nervous system anatomy and localization principles. The remainder consists of excellent descriptions of twenty-nine illustrative cases with history, important questions, discussion and diagnosis in each case. Here are included the chief types of lesions from the peripheral nerves and spinal cord groups to the brain stem, cerebral and cerebellar syndromes. Satisfactory diagrams are given to show clinical phenomena in the patient and the gross lesions in the nervous system. A complete index is provided.

It may be noted that in the first part, under the heading "Cranial Nerves," there is no mention of the first, second or eighth, these having been taken up previously under "Sensation." The course of the taste fibers is, under this arrangement, given twice.

The absence of detailed discussion of disputed points is to be commended in a book of this type. The student's first introduction to clinical neurology should engender enjoyable interest and not the too common feeling of hope-

less confusion. However, a few points such as the Wernicke pupillary phenomenon might better be given with a hint of arguments to come.

This book should have a real place as it has a real function. At the impressionable period of beginning clinical medical work, it should fix the fickle interest of many a student and distinctly increase the popularity of undergraduate study of neurology. The value of this in the production of efficient practitioners and specialists alike is obvious.